DOCUMENT RESUME

ED 043 236 40 EM 008 481

AUTHOR	Yens, David P.; And Others
TITLE	The Development and Evaluation of a Computer-Based Pure Tone Audiometer Trainer. Final Report.
INSTITUTION	Pennsylvania State Univ., University Park. Computer-Assisted Instruction Lab.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C. Bureau of Research.
REPORT NO	R-23
BUREAU NO	BR-7-0733
PUB DATE	Sep 69
GRANT	OEG-2-7-070733-4586
NOTE	167p.
EDRS PRICE	EDRS Price MF-$0.75 HC-$8.45
DESCRIPTORS	Audiologists, *Audiology, Audiometric Tests, Audiometrists, *Computer Assisted Instruction, Medical Education, Medical Technologists, Simulation, *Simulators
IDENTIFIERS	ATU, *Audiometer Trainer Unit

ABSTRACT

Since it is impractical to have students test patients for hearing loss, training in basic pure tone audiometry is usually inadequate. To remedy this, a simulated audiometer was developed that interfaced with an IBM 1500 instructional system for computer-assisted instruction, and a course of instruction was written in Coursewriter II. The instructional portion of the program was tested with 27 subjects of varying backgrounds in audiology. Sixteen subjects produced acceptable audiograms on the criterion task; of those who did not, all but two showed improvement during the criterion task. No systematic relationships were found between time for the course, number of errors, and final performance. Students performed equally well, whether they had had experience with audiometry or not. Extension of the course to include more sophisticated audiometric test procedures, addition of an audio capacity, and improvements to the Audiometer Trainer Unit are recommended. It is suggested that the concept can be applied to other health-related devices and training. Appendices include theory and maintenance instructions, an instructional manual, course frames, computer listings, a course outline, an oral postprogram questionnaire, and sample of Unit 3 audiograms. (MF)

ED043236

C·A·I

COMPUTER ASSISTED INSTRUCTION LABORATORY

COLLEGE OF EDUCATION · CHAMBERS BUILDING

THE PENNSYLVANIA STATE UNIVERSITY · UNIVERSITY PARK, PA.

THE DEVELOPMENT AND EVALUATION OF A COMPUTER-BASED AUDIOMETER TRAINER

September 1969

Report No. R-23

EM008 481

ED0 43236

Final Report

Project No. 7-0733
Grant No. OEG-2-7-070733-4586

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

The Development and Evaluation of A Computer-Based Pure Tone Audiometer Trainer

Prepared by
David P. Yens

Principal Investigators
Bruce M. Siegenthaler
and
Harold E. Mitzel

The Pennsylvania State University
201 Chambers Building
University Park, Pennsylvania 16802

September 1969

The research reported herein was performed pursuant to a grant with the Bureau of Education for the Handicapped, U. S. Office of Education, Department of Health, Education, and Welfare. Contractors undertaking such projects under government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official position of the Bureau of Education for the Handicapped.

Department of Health, Education, and Welfare

U. S. Office of Education
Bureau of Education for the Handicapped

FOREWORD

Most applications of computer-assisted instruction today use either drill and practice or tutorial modes of interaction with students. Both these modes of instruction can be highly sophisticated and can make lasting contributions to the education of children and adults. Unfortunately, however, much of what has been produced has been criticized as being an expensive method of page-turning. Critics state that what was done with the computer could have been done by other methods at much less cost. To some extent the critics may be right. When a course author is given a limited time to produce a systematic course of instruction and must use a language that is difficult to use and limits flexibility, the result usually is much like a scrambled text. The computer merely turns pages and keeps score of right and wrong answers.

Computer-assisted instruction need not be limited to the tutorial and drill and practice modes. Indeed, two additional modes of student-computer interaction promise to be very powerful pedagogical devices. One is an interaction that is a true dialogue: the student asks questions in his natural language of the computer and the computer provides answers. The second mode is the use of the computer as a simulator of some process or device that is to be learned by the student. The dialogue approach is presently limited by the ability of the computer to accept and process only limited amounts of natural language. Consequently, widespread use of the dialogue mode of instruction is still in the future. Rapid strides have been made using the computer as a simulator, however, and some gaming and medical diagnosis programs where the computer plays the role of the patient or opponent have already been developed. Simulation may be more appropriately applied to the situation where some device is simulated and connected to the computer. Both of these uses of the computer as an instructional simulator should enhance its value to the health professions.

The application of computer-assisted instruction to the health fields can be supported by very persuasive arguements. Practitioners in the health-related fields must learn a great deal of detail, all of which must be brought to bear on each problem to be solved, diagnosis made, or treatment prescribed. Frequently there is no opportunity to consult references or other aids during the decision-making process. Traditionally, knowledge has been gained through intensive study and memorization. The information explosion is now placing tremendous strains on this method of learning; help is needed. In addition, knowledge of many new devices, developed by our technology for the health fields, must be added to an already overburdened curriculum or must be gained on the job when time is at a premium. Computer-assisted instruction may help to alleviate these serious problems. It has already been used as an aid to teach elements of medical knowledge such as pathology and anatomy and has even been used to simulate a patient for practice in diagnosis. In the field of audiology, a course has been developed that teaches basic elements of the hearing process.

The field of audiology may be considered typical of health-related disciplines. Within audiology, as with all other health-related fields, there has been a rapid growth of knowledge. Audiologists also must gain familiarity with the audiometer and the methods of using it to give hearing tests. The project described in this report was concerned with improving the training of students in the use of the audiometer and the administration of hearing tests. This training was done on a computer-assisted instructional system with a simulated audiometer that was connected to the computer. Such a project may be considered a prototype of analogous endeavors in other fields.

In a complex project of this type, the assistance of many people is needed, and debts of gratitude are owed to many of those at the Penn State CAI Laboratory who contributed to the effectiveness of the program. Special thanks go to Mr. Paul Peloquin and Mrs. Leslye Bloom who prepared the special displays for the display screen and to Mr. Terry Bahn, Mr. Fred Chase, and Mrs. Carol Dwyer for valuable technical assistance. To Mrs. Irene Cashell, who helped work on the program, sat with many of the subjects, and analyzed the preliminary data, and to Mrs. Bonnie Shea, who spent many tedious hours culling the final data from voluminous student records, very special appreciation is due. The administrative support provided by Mrs. Betta Kriner and Mrs. Kris Sefchick made the completion of the project possible. Finally, a special acknowledgement must be made to Mr. Richard C. Rivett of IBM, Federal Systems Division, who designed the ATU and made many special trips to make modifications and to insure that the ATU performed satisfactorily.

David P. Yens
University Park, Pennsylvania
October 6, 1969

TABLE OF CONTENTS

Page No.

FOREWORD ii

TABLE OF CONTENTS iv

LIST OF TABLES. vi

LIST OF FIGURES vii

SUMMARY 1

INTRODUCTION. 2

METHOD. 4
- Development of Simulated Audiometer Terminal and Interfaces. 4
- Computer Programing Course Material. 8
- Development of Course Strategy and Content 8
- Problems Unique to This Program. 11
- The Program of Instruction 14
  - Unit 1 14
  - Unit 2 15
  - Unit 3 16
- Method of Evaluation 16

RESULTS 17
- Statistical Results. 17
- Observation and Interview Results. 26

CONCLUSIONS 30
- Recommendations. 34

REFERENCES. 37

APPENDIX A
- Audiometer Trainer Unit - Theory and Maintenance Instructions. 39

APPENDIX B
- Audiometer Trainer Unit - Instructional Manual 75

APPENDIX C
- Written Course Frames. 103

APPENDIX D
- Computer Listings of Representative Portions of the Audiometry Course 113

TABLE OF CONTENTS (cont'd)

Page No.

APPENDIX E
Technical Aspects and Problems 117

APPENDIX F
Detailed Course Outline. 127

APPENDIX G
Oral Postprogram Questionnaire 131

APPENDIX H
Samples of Complete Unit 3 Audiograms. 135

LIST OF TABLES

Table Page No.

1 Sequence of Behavioral Objectives 10

2 Characteristics and Relevant Background of Students . . 18

3 Summary of the Total Time for the Course, Time for Unit 3, Ranking of Students on Time, and Number of Visits Needed to Complete the Program 19

4 Summary of Entries Made, Attempts, Attempt Rate (AR), and Ranking of Students by Attempt Rate 22

5 Student Performance on Unit 3 Threshold Finding Task. . 24

6 Relationship Between Selected Performance Measures and Selected Learner Characteristics. 25

7 Attitudes and Comments by Subjects Concerning the Course. 28

LIST OF FIGURES

Figure Page No.

1 Chronology of development and programing of simulated pure tone audiometer 5

2 Photograph of completed audiometer panel 7

3 Photograph of the terminal used for audiometry students. 9

4 Interpretation of the input to the computer from the ATU 12

5 The audiograms for the right ear (Unit 2) and the left ear (Unit 3) of the patient tested by the subjects . . . 23

SUMMARY

The typical training of students in basic pure tone audiometry is inadequate because students use an audiometer to test others whose hearing is normal and they generally receive no information on the correctness of their technique during practice. In order to provide a monitoring capability as well as a variety of hearing losses, a simulated audiometer was developed that interfaced with an IBM 1500 instructional system for computer-assisted instruction. A course of instruction in the use of the audiometer and audiometric testing was written in Coursewriter II to teach students to use the method of limits to obtain hearing thresholds without guidance.

The instructional portion of the program was tested with 27 subjects of varying backgrounds in audiology; 24 completed the course. Experienced audiologists, students in audiology, nurses, and subjects in completely unrelated fields comprised the sample. Data were gathered on the number and types of errors made, time taken, and performance on a criterion threshold finding task. An oral questionnaire was administered after completion of the program. The average time to complete the course was 132 minutes.

Sixteen subjects produced acceptable audiograms on the criterion task. Of those who did not, all but two showed improvement during the criterion task. No systematic relationships were found between time for the course, number of errors, and final performance. There was also no correspondence between selected student characteristics and the course measures obtained. Students performed equally well whether or not they had had previous experience with audiometry. They uniformly liked the course and thought it was a good method for learning.

With the added practice which was omitted from the subject trials, it is anticipated that all students would reach an acceptable level of audiometric testing practice. Use of the course is recommended for college students in audiology, nurses, audiometric technicians, and for proficiency maintenance purposes. Extension of the course to include more sophisticated audiometric test procedures, the addition of an audio capacity, and improvements to the Audiometer Trainer Unit are recommended. The success of the simulated audiometer as a teaching device suggests that this concept can be applied to other health related devices for which extensive practice is needed to gain proficiency.

INTRODUCTION

The beginning course in audiology (SPA 430) at The Pennsylvania State University is typical of the beginning course taught in audiology at colleges and universities across the United States. Approximately 150 institutions of higher learning teach such a course. To the investigators' knowledge, all of these courses teach at least some pure tone audiometric test technique, and include at least some audiometric test practice.

The experience at Penn State in offering the desired amount of pure tone testing practice to the enrolled students is typical. A class enrollment normally is between twelve and thirty students, two terms per year. At the present time, the requirement is that each student do a pure tone air conduction audiogram, for six frequencies in both ears, on at least ten practice subjects. (This requirement of ten audiograms is a minimum for development of adequate audiometric testing skills.) For a class of twenty students, this requires 200 audiometric tests. The number of subjects available for testing is limited. It is typical for the students to be listeners for each other as they administer audiometric tests for practice. However, this exchange of time has a severe limitation in that nearly all students in the course have normal hearing. It is impractical to use clinic patients for student testing, both because of the responsibility for professional level of services to clinic patients, and because of the limitations on the time that can be demanded of a patient for testing practice by students.

During their testing practice, students normally are unable to test subjects with a variety of hearing disorders or with a variety of patterns of response. A related problem is that, in order to do tests on human subjects, an audiometric sound-isolated room is required for each testing station. These rooms not only take up considerable floor space, but are expensive to provide for student practice, and normally are not available in sufficient quantity with necessary audiometric test equipment.

It is clear that in order to provide students-in-training with adequate audiometric test practice experience, techniques not now available should be developed.

In addition to students-in-training, there is another large group of audiometric test practitioners. These are school and industrial nurses. In many states, it is required that each year school children receive pure tone hearing tests. Usually these are administered by the school nurse, although in some places speech therapists or technicians may be used. In industrial situations, the plant nurse very often is required to do the intake audiogram and monitoring audiograms of the wrokers employed in noisy environments. This group of in-service school and industrial nurses comprises a much larger group than audiology students-in-training.

In the typical nurse's training program no specific work is given in administering audiometric tests, or there is no more than a lecture or two about hearing testing. When the nurse finds herself on the job with the requirement to do audiometric testing, she typically is able to do little more than read the manufacturer's book about her audiometer and to talk to the hearing aid and audiometer distributor. These sources of instruction are woefully inadequate.

In some instances, the state department of health or education personnel are able to give school nurses some field instruction, but the situation in Pennsylvania is not atypical. In the Department of Health, which is charged with the responsibility for the statewide school testing program, there are two employees in the audiological and hearing conservation area. There are two state level employees in the Department of Public Instruction. Although they have attempted to instruct the school nurses in Pennsylvania on proper test procedures, they can do little more than make occasional contacts with the nurses. An automated program for providing school and industrial nurses with a short intensive course in good hearing test administration practice would help alleviate this serious problem.

The concept of developing a computer terminal and programing the computer to play the role of a person with hearing loss is consistent with the development of concepts for using computers to simulate live patients having various diseases and utilizing the computer to assist in medical diagnoses (Swets and Feurzeig, 1965). Not only does the student-in-training have the opportunity to be presented with a wide variety of symptoms, he also has the opportunity to have a wide variety of untiring "patients."

The computer-simulated subject for a hearing test provides several advantages. The actual pattern of each tone given to a "patient" can be noted and a critique can be given to the student. Student audiometricians can follow a sequence of increasingly difficult patients to test. The student can report the results of his test findings to the computer, and immediately have them checked against the correct hearing status. He then can be led into a repeated series of tests of the same or different "patient ears," depending upon his level of test competence. The computer simulation of hearing test situations can provide a student with as much practice as he desires upon his own demand, or as much as he needs according to his proficiency. It is well within the capabilities of the present computer state-of-the-art to provide such things as temporary threshold shift in an audiogram, variabilities in attention, patient fatigue, a wide variety of audiometric test patterns, responses typical of subjects with non-organic hearing loss, and responses for tests other than threshold (loudness balance, equal loudness contours, difference limen for loudness, short increment sensitivity index, and so forth.)

The specific objectives of the present project were:

1. To develop an audiometer-type terminal to be used in the computer assisted instruction setting in conjunction with existing hardware.

2. To write a computer program simulating subjects with normal hearing and with threshold hearing losses, including the typical types of audiometrics patterns normally seen in clinical practice.

3. To make a field trial of the computer terminal and its associate teaching program, using University students-in-training and a sample of nurses.

It is not proposed that the computer training technique would be desirable as the only method for student audiometricians. Rather, after some initial instruction, the student could develop basic manipulative skills for hearing test administration. He could be led through the threshold decision making process, and he would be given testing practice via the computer technique. After such a period of training and experience, he would proceed to further practice with live subjects. It is in the earlier phase, prior to live-subject practice, which is of interest to the present project.

METHOD

The development and programing of a simulated pure-tone audiometer consisted of five phases:

1. Development of simulated audiometer terminal.
2. Engineering aspects to the interface between simulated audiometer terminal and telephone line/computer.
3. Development of strategy and content of course of instruction and practice.
4. Programing of course content for the IBM 1500 computer system using the Coursewriter II language.
5. Tryouts of material with audiology students and nurses, with concurrent program corrections and modifications as necessary.

A diagram charting the development of each part of the project is found in Figure 1.

Development of Simulated Audiometer Terminal and Interfaces

American brand pure tone audiometers, although produced in a variety of sizes and models by several major companies, have several common features. A representative audiometer panel was designed that incorporates these common features.

The audiometer panel is mounted in a box similar to that of a standard clinical American pure tone audiometer. Dial labeling, knob size, and so forth, represent the generally accepted practice in the field. The essential features and typical characteristics of a standard pure tone American audiometer are included with labeling indicating International Standards Organization - 1964 calibration. The audiometer panel contains the standard audiometric elements of:

Activity	Time Devoted to Activity
1. Specification and location of typical audiograms	July 1967 - September 1967
2. Development of course objectives	September 1967 - November 1967
3. Design, production, testing of ATU by IBM, Federal Systems Division	September 1967 - April 1968
4. Learning of material and sequencing of objectives	October 1967 - February 1968
5. Design of ATU panel	October 1967 - November 1967
6. Preparation of Part I frames, analysis procedures, and remedial sequences	November 1967 - May 1968
7. Installation of 1500 System	December 1967
8. Trial computer programs for panel analysis	January 1968 - April 1968
9. ATU debugging and modification	April 1968 - July 1968
10. Coding, testing and revision of Part I	April 1968 - December 1968
11. Preparation of Part II frames	March 1968 - September 1968
12. Coding, testing and revision of Part II	August 1968 - March 1969
13. Design, coding, testing and revision of Part III	December 1968 - March 1969
14. Preliminary tests with subjects	March 1969 - April 1969
15. Program revision	March 1968 - June 1969
16. Final subject trials	April 1969 - June 1969
17. Data analysis and final report	June 1969 - August 1969

Fig. 1. Chronology of development and programing of simulated pure tone audiometer.

1. Frequency selector (octave frequencies and half-octave frequencies 125 through 8000 Hz, as on most audiometers)
2. Hearing level dial (in five-decibel steps from minus ten through 110 decibels)
3. Tone interrupter switch
4. Power on - off switch and light
5. Masking sound level control
6. Right earphone, left earphone, bone conduction output selector switch
7. Patient signal light
8. Operational switch for SISI test administration
9. Operational switch for loudness balance testing
10. Tone warble switch
11. Tone normal on - normal off switch.

Chanel 1 controls are grouped on the left hand side of the panel; chanel 2 controls are grouped on the right.

A photograph of the completed panel is provided in Figure 2.

Engineering design, development and production of the simulated audiometer terminal, or Audiometer Trainer Unit (ATU), and interfaces were done by the Federal Systems Division of IBM at Gaithersburg, Maryland, on a subcontract basis. The terminal was designed to interface with a voice-grade telephone line to an IBM 1400 series computer system or directly with the IBM 1500 instructional system. Photographs and specific design, development, interface, and programing considerations are provided in the IBM publication included as Appendix A of this report. An instructional manual for the ATU by IBM is Appendix B.

The ATU was connected to the IBM 1500 Instructional System at Penn State on April 15, 1968. However, an additional modification had to be made to permit the timing of a "tone" given by a student. Consequently, the ATU was not fully operational until July, 1968, although it could be used to some extent for program development.

A special device has been used as an interface between the student and a computer by earlier investigators to teach stenotypy (Uttal, 1962) and card punching and typewriting (Lewis and Pask, 1965). However, these earlier applications required special computer equipment or hardware modifications and did not use verbal communication as a part of the instructive process. For the present system, the audiometer trainer unit was designed to directly interface with the 1500 system (described in Appendix A) and all instructional capabilities of the 1500 system are utilized.

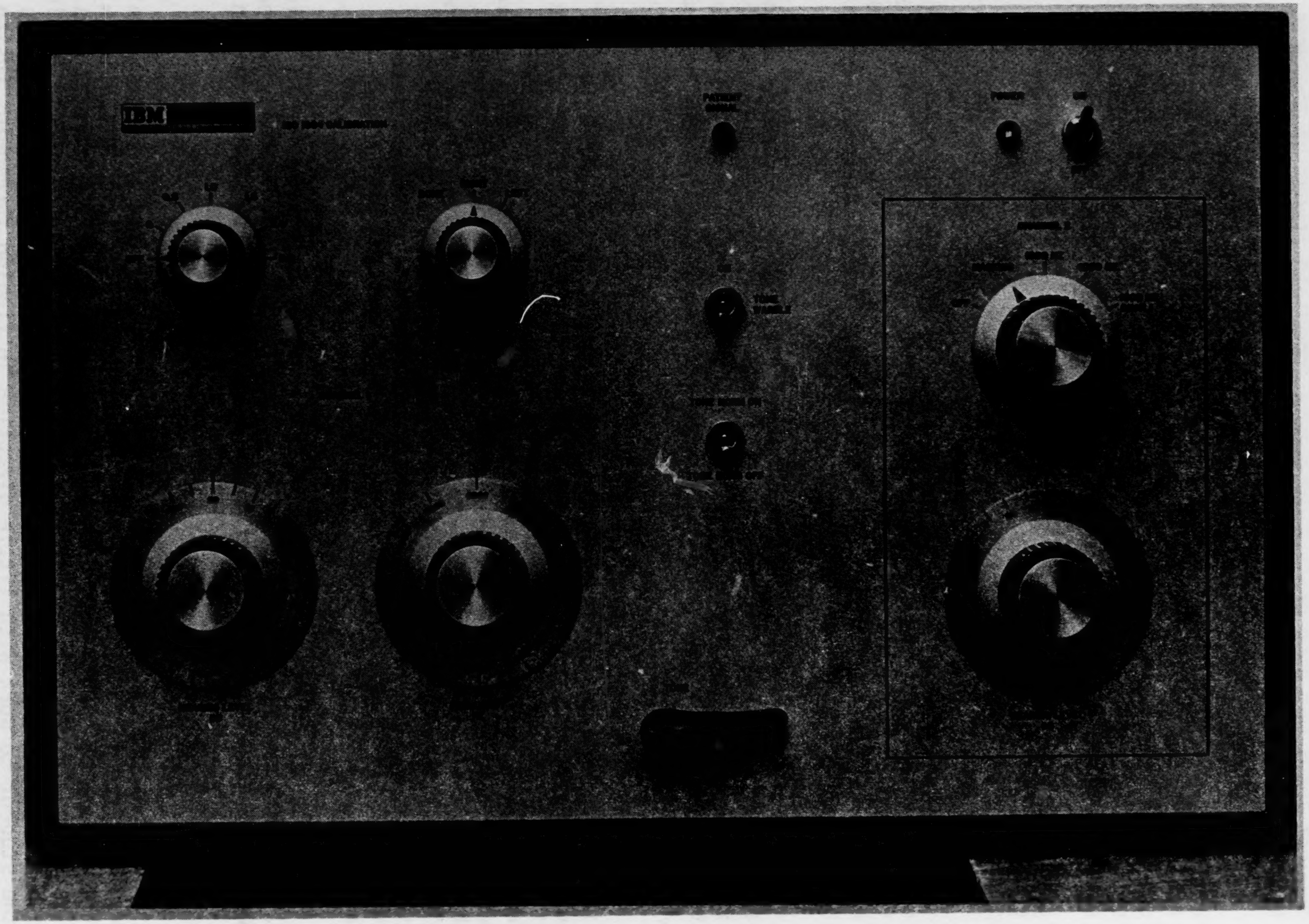


Fig. 2. Photograph of completed audiometer panel.

Computer Programing Course Material

The Coursewriter II language was used for programing. Much of the program input was done on-line to permit immediate tryout of the entered material; card input was used when possible.

The terminal used for students, illustrated in Figure 3, consists of an IBM 1510 keyboard and display screen with light pen, an IBM 1512 Image Projector, and the Audiometer Training Unit. Computer control can be activated for any of these elements, and inputs can be made from the 1510 or ATU. Output and source of input is under program control; an input cannot be made from more than one unit at the same time.

Development of Course Strategy and Content

The threshold finding technique taught is a modified method of limits, using a descending, an ascending, and another descending series of tone intensity levels to cross auditory threshold again. Threshold is defined as the lowest intensity level (in db) at which at least two hearing responses are obtained. Decibel steps are 10 db initially, and 5 db when operating near the anticipated threshold.

One of the final objectives of a basic course in audiometry is for the student to be able to use specified techniques of threshold finding to obtain audiograms from subjects with a variety of hearing and response characteristics, and be able to be within ± 5 db of the correct hearing level at each frequency.

The initial phase of this project consisted of analyzing the threshold finding task to determine the required skills and in what order they should occur. During all development phases, close cooperation with subject matter experts was maintained. From this analysis emerged a set of behavioral objectives that would form an initial framework for course development. They were placed in an initial sequence, based on the task analysis, that provides a stepwise learning experience in which primary skills are learned first. As proficiency in primary skills is developed, new skills are integrated in a pyramidal fashion until all skills are brought together and the desired proficiency is attained.

These objectives are listed in their approximate sequence in Table 1. It can be seen that the sequence is quite logical, and generally approximates the sequence of learning provided in the classroom. However, in the classroom there is little opportunity for guided practice at each stage.

It was decided that the objectives be divided into three basic units, as indicated in Table 1. The first unit consists of familiarization with the audiometer panel - how each switch and dial works and what it does. The second unit consists of initial guided practice in threshold finding and specification of the specific techniques used. The third requires the student to work with little direction in finding thresholds (using

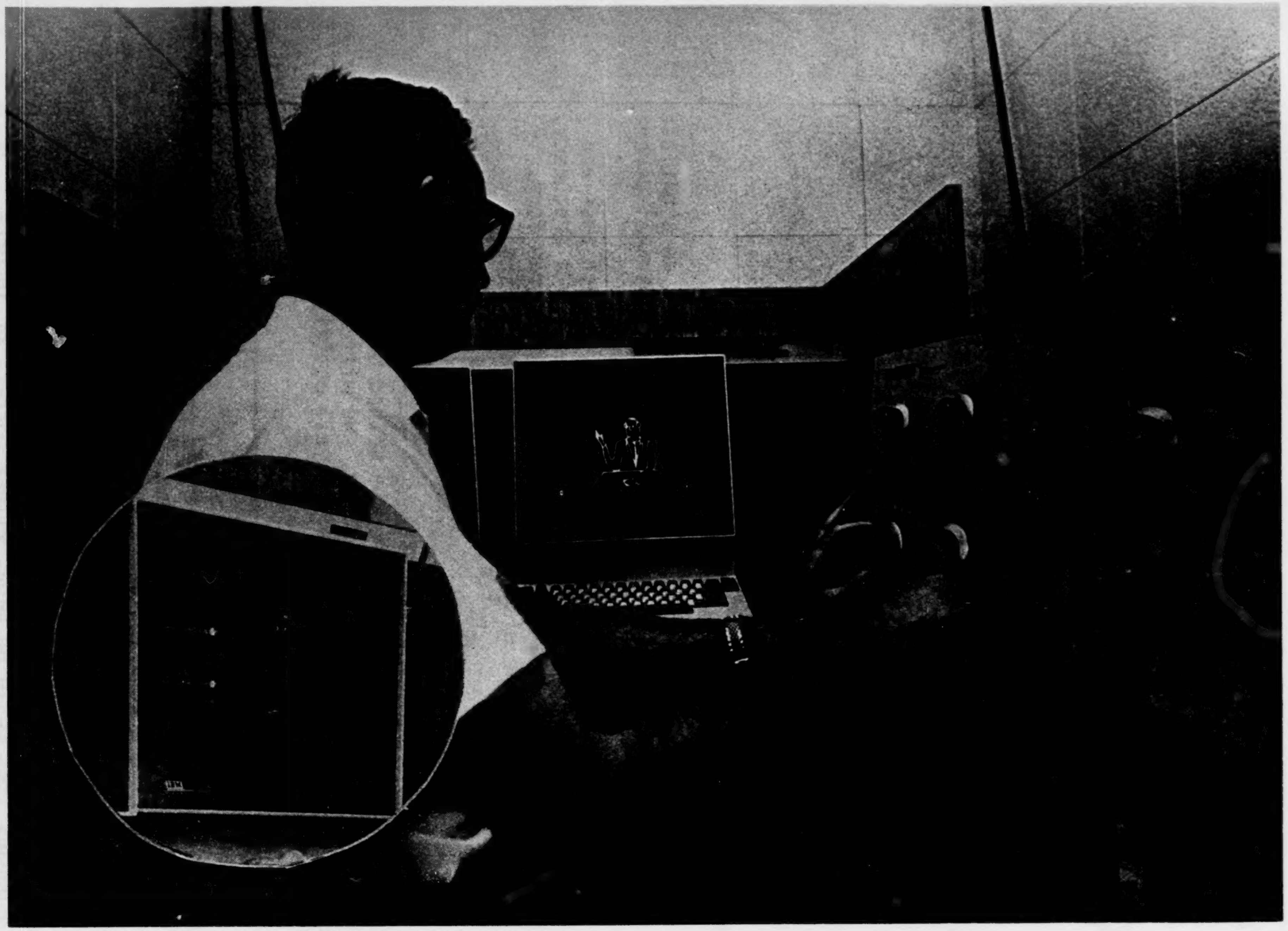


Fig. 3. Photograph of the terminal used for audiometry students. The image projector is at left, behind the student; the display screen at center shows the "patient" with his hand up (the inset shows the hand down position), and the ATU is at right.

Table 1

Sequence of Behavioral Objectives

Unit 1

The student will be able to:

1. Turn on the audiometer
2. Manipulate the tone switch in accordance with accepted procedure
3. Manipulate the following and set them as directed:
    a. Channel 1 Output
    b. Channel 1 Hearing Level
    c. Channel 1 Frequency
4. Set the following to their off positions and leave them off during basic audiometric testing:
    a. SISI
    b. Tone Warble
    c. Tone Norm
    d. Channel 2 Output
    e. Channel 2 Hearing Level

Unit 2

The student will be able to:

1. Recognize correct placement of earphones on a patient
2. Properly use the method of limits with minimal direction for finding hearing thresholds.
3. Determine the estimated threshold for each pass and specify the final obtained threshold for a frequency.
4. Plot the obtained threshold on an audiogram form.
5. Describe the elements of the threshold finding technique.

Unit 3

The student will be able to use the method of limits to obtain hearing thresholds without guidance. He will test frequencies in the appropriate order and perform all activities required in testing.

---

the fading technique) and permits him to build proficiency in dealing with different types of threshold patterns. He is provided with the opportunity to check his work (obtained audiogram) at once.

Following the specification and sequencing of objectives, a program was written on paper that consisted of each display that would appear on the cathode ray tube (CRT) or image projector and the analysis of the logical responses that could be made, either correct or incorrect, with the results of each. This constituted a "dry run" program that could be reviewed, tested, and changed easily before actual computer program was initiated. A portion of an early version of this program is found in Appendix C. This type of program was very useful for Part 1, but less useful for Part 2, and of little use for Part 3, which is highly unstructured.

During this initial programing phase, an analysis of the entry skills and abilities of probable students was made to determine whether initial instruction or review was appropriate to each objective. Beginning students in audiometry would have attended an introductory lecture; for them most of the objectives would require original learning. However, a second source of students would be nurses who may or may not have had experience in audiometry. Consequently, an option to skip the introductory section was included, but it required the demonstration of proficiency in setting the panel before the skip could be completed. Failure on this pretest started the student at the beginning of the instructional material.

The written version of Unit 1 was tested with a limited number of students. As each frame (text display) was shown to the student, he responded verbally or on the ATU. The author simulated the computer by providing feedback and proper sequencing of frames based on the responses. This actually provided added data on student response characteristics, and allowed modification of the program prior to programing for the computer. The written version was useful for Unit 1 because this unit primarily consisted of instructional frames with a variety of branching possibilities. Unit 2 was basically guided practice in giving audiograms, for which written simulation was of limited use.

Although a textual representation of course material provides a framework which could greatly simplify the programing of ordinary instructional material, the use of the ATU required a much more complex program which required a great deal of programing time. Without the initial text, however, the course development would have been more difficult.

Problems Unique to This Program

It was decided to maximize student use of the ATU during all phases of the program. In order to monitor student responses, it was necessary to "read" and evaluate the ATU each time the student responded.

The ATU input to the computer is an eight bit word with each bit representing the setting of one switch or dial. An example of one word, with the meaning of each bit, is given in Figure 4. The correct answer can be easily determined by comparing the input with the correct word which was previously stored. However, it was considered important to tell the student exactly where he made an error if the panel setting was wrong. To do this, the input word had to be broken down into eight parts and each part tested with a conversion table. For example, if the word in Figure 4 was the correct "answer" but the student response was 1B510010, the computer would detect a mismatch of the whole word and then examine each part to determine where the mismatch occurred. In this case, it would detect a match on the first bit but a mismatch on the second bit.

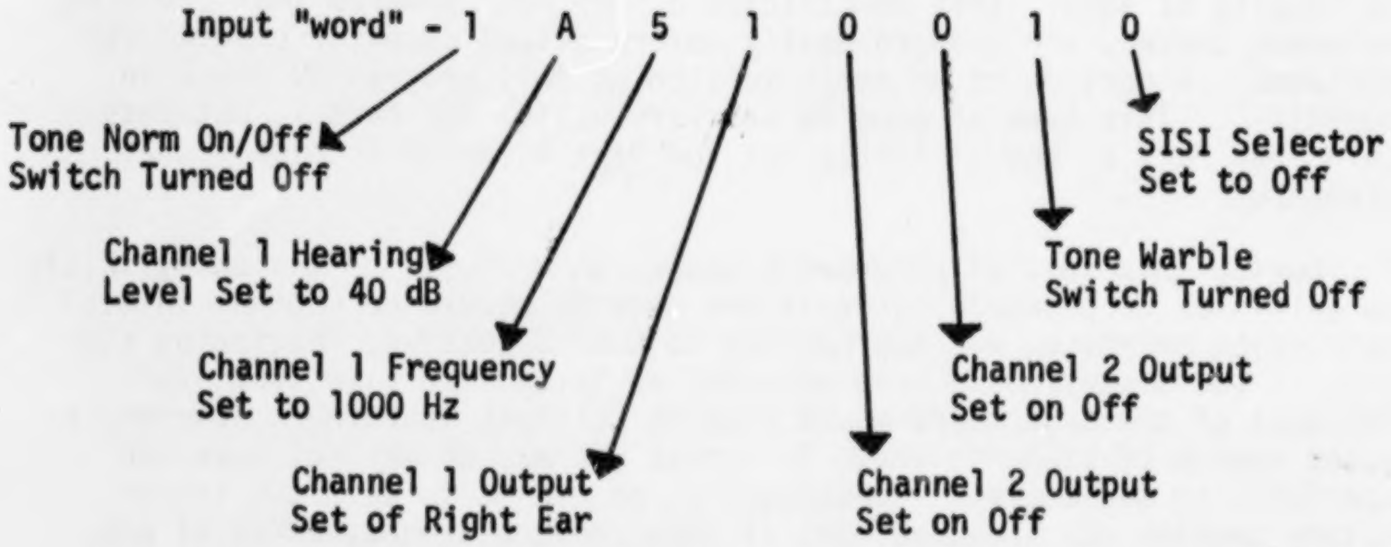

Input "word" - 1 A 5 1 0 0 1 0
Tone Norm On/Off Switch Turned Off
Channel 1 Hearing Level Set to 40 dB
Channel 1 Frequency Set to 1000 Hz
Channel 1 Output Set of Right Ear
Channel 2 Output Set on Off
Channel 2 Output Set on Off
Tone Warble Switch Turned Off
SISI Selector Set to Off

Fig. 4. Interpretation of the input to the computer from the ATU

It would then enter a table specifically related to Channel 1 Hearing Level and look for a match for the input value (in this case, the B). When it found the match, it would store the associated value (45) in a location where it would later be used in a message to the student. The program would then test the remaining bits and find a match for each one. After the completion of the tests, a message to the student directing a correction in Channel 1 Hearing Level would be displayed. This process was repeated for each input through the ATU.

A second programing requirement was to time the duration of each tone given by the student with the audiometer. The tone switch (or interrupter switch) transmits the word describing the panel each time it is depressed and again when it is released. The real time in seconds between depression and release is measured with a complex process that minimizes the effect of activity at instructional terminals other than the ATU. The time measurement is displayed for the student and evaluated as part of the instruction to him regarding audiometric technique.

The complexity and anticipated length of the program caused program efficiency and brevity to be major factors in program development. Because of the newness of the IBM 1500 system and Coursewriter II, it required many months before enough was known to insure an optimally efficient routine; many versions of critical sequences were coded and tested before they ran with adequate speed. This activity was important to insure rapid feedback to the student. For example, much of Unit 2 consists of leading the student through threshold finding procedures. To make this experience as realistic as possible, a "patient" is displayed on the terminal display screen (see the display screen contents in Figure 3). When the student gives a correct tone that the "patient" can hear, the "patient's" hand is raised. When the tone stops (release of tone switch), the hand is lowered.

The "patient" was displayed using normal "dti" instructions and a graphics dictionary developed by the CAI Laboratory (see Peloquin, 1968, for further information on the graphics dictionary), rather than using a graphic set. This was done to allow greater flexibility in the placement of the display on the screen, to allow modifications if they were later needed, and to minimize the requirements for dictionary storage space. Subsequently, the instructions were written in MACRO form to allow the placement of the "patient" anywhere on the display screen.

It was essential that the "patient's" hand be raised within one second of the depression of the tone switch to simulate a realistic patient. However, during this interval the panel had to be checked for correctness and the timing process started before the hand could be raised on the screen. Initially, this process was much slower than acceptable, and it took three months, many revisions of the program, and an investigation of alternatives to the raised hand to find a solution that was acceptable. A further discussion of this problem is provided in Appendix E.

It was decided to write the patient's hand and time sections as subroutines because these same coding sequences were used by more than one hundred frames. The length of coding of these sequences, if repeated over 100 times, would be excessive. It was determined that by proper placement in the sequence of frames, accessing time could be minimized and much space on the disk storage would be saved.

The complex coding to measure the duration of time between tone switch depression and release was necessitated by the fact that fifteen instructional terminals are attached to the computer on a time sharing basis. Each terminal is polled in turn to determine if processing is required. If it is, processing continues until the program reaches an instruction (an ep) to look for a new response from that terminal, until a specified number of instructions have been processed, or until processing is interrupted by a job with a higher priority. At this point, processing of the next terminal requiring attention is initiated. Because of computer cueing, the time being measured between two responses might be interrupted by the processing of information from other terminals. To overcome this it was necessary to read the computer's internal clock before each request (ep), time the latency of each response, and then calculate the actual duration from these four measures.

The obtained time is tested against the accepted limits for tone duration (2 to 4 seconds); if it is within the correct range, the time is displayed to the student. If it is incorrect, a counter is incremented to store the error and the time is displayed with a message indicating whether it was too short or too long as well as a statement of the acceptable length.

The most difficult problem faced was the efficient analysis of the eight bit input word from the ATU. Because it was instructionally desirable to minimize the time between response and feedback, the initially obtained processing times of four or more seconds were unacceptable. As with the raising of the hand, a variety of programing techniques were attempted before an acceptable one was found.

The resulting method uses a drop through procedure. The input word is first tested for correctness. If correct, feedback is provided and the next frame in the sequence is presented. If incorrect, the bits in the word are sequentially tested. If a bit is correct, the program drops through to test the next bit. If incorrect, the bit is used to enter a table to determine what position on the dial or switch it represents. This position is stored for later use and the program goes on to look at the next bit. The program looks at each bit in this way until it reaches the end of the word, at which point a message is displayed that points out each of the errors made, states what should be done, and requests the student to try again.

This process was simplified somewhat when it was decided to group four of the bits, representing little-used functions, into one unit for analysis. Other shortcuts were taken where it was pedagogically feasible.

The Program of Instruction

The table of objectives (Table 1) provides a general overview of the program. A complete outline is provided in Appendix F. Based on extensive classroom experience with students in audiology, it was decided to use a maximum of practical "hands-on" experience with the Audiometer Trainer. This decision is consistent with the view of experts in programed instruction that each frame should be objective-oriented and that unnecessary enrichment will tend to confuse the student and inhibit progress toward the objective.

The plan of the course consists of a main-line sequence of frames with remedial branches from each frame contingent upon the student's response. Extensive student control of the program is provided through giving the student the option of review or repetition of material at several points and through permitting him to skip sections if he desires. If he skips a section unwisely, however, the remedial branching capability will provide him the opportunity to review what he missed. At the end of major instructional units, the student's performance for that unit is displayed and recommendations are made concerning his continuation (e.g., go on, review, or go through the section again.) However, the continuation option is left to the student.

Unit 1

It was determined that all familiarization with audiometer panels and learning of threshold-finding techniques should be done with the ATU, although for speech and hearing students it would be preceded by one lecture concerning the topic. Unit 1 provides familiarization with the functions of each of the elements of the ATU panel and provides graded experience in the use of the commonly used ones.

The student initially learns how to turn on the panel power switch and how to use the tone switch. The concept of giving a tone for a specific duration is introduced during the use of the tone switch, and the tone duration is timed and displayed to the student after each tone input. Practice in giving tones for the correct duration is provided at the student's option after initial familiarization.

The operation of switches and dials is introduced one by one in order of importance. Practice with each one is provided before the introduction of the next, then practice with all those learned is given.

Finally, the student is given instructions to set the panel in different ways using all the elements of the panel. After successful completion he goes on to Unit 2, or he may select added review or practice.

Instruction is provided primarily by the display screen; instructions are given concerning where to find and set the panel elements. However, after one unsuccessful solution of a problem, a slide (frame of film on the image projector) is displayed showing the panel and the way it should be set. Although it would have been feasible to introduce each panel element with a picture, it was decided that subjects would gain better familiarity with the panel if they had to look for each element.

After learning the elements of the ATU panel, the subject is given the opportunity to use a standard portable audiometer (also available at the terminal station) in order to hear for himself what the different switches do and how the tones sound.

Unit 2

Unit 2 consists of training in the threshold finding technique. It is introduced by a review of the placement of earphones, with slides used to demonstrate correct and incorrect placement. A glossary can then be accessed by students who may want to review vocabulary words used in audiometry. The student is introduced to the method for determining the initial hearing level of a test, and is then directed through a test procedure for all frequencies of the right ear (in which a variety of thresholds and patient responses are represented). During this series the student interacts with the "patient" on the display screen which raises its hand if the tone is above the programed threshold. The student is directed to give a specific hearing level each time; a running account of the levels tested and the response is provided on the display screen, and at approrpiate points the student determines the estimated or final threshold. All panel elements are monitored so that if the student makes an error he receives a message telling him what he should have done and giving him the opportunity to repeat the tone correctly.

Toward the end of the testing of the right ear, the student is successively asked to guess what next hearing level for a frequency should be given, and finally he types each hearing level value before he gives the tone. In this way, he gains familiarity with the process being used before he actually has to reproduce it on his own.

After each frequency threshold is obtained, the student uses the light pen to mark his obtained threshold on an audiogram form displayed on the display screen. After plotting the point on the screen, he marks it on a standard audiogram form. Thus, he completes the form as he would during the normal testing of a patient.

Following the test of the right ear, the student's performance is displayed and options for review or further practice are provided. This is followed by a review of the techniques used. In the review the student specifies the specific step-by-step procedure he used, indicating his responses on the keyboard. In this way, specific knowledge of the steps can be assessed and misconceptions corrected before the student progresses to Unit 3.

Unit 3

In this unit the student is introduced to the need for a limited interval between tones. He is then allowed to test the left ear of the "subject" with a minimum of direction, using the procedures learned in Unit 2. Thresholds are programed for each pass (ascending and descending) within each frequency, and these thresholds usually differ slightly within each frequency so that a third pass will usually be needed. Further audiometric patterns are used in this test, which simulates more closely the testing of a live patient. If the student desires, he may obtain information on the duration of his tones and pauses.

After completing the test of the left ear, the student enters his obtained thresholds via the keyboard, to compare his audiogram with the correct one.

This unit was initially used to determine how well students learned from the first two units. It was found that some additional feedback capability was needed, especially for a frequency that has a threshold significantly higher than the preceding ones, and a review option was thought to be necessary. As indicated in the following section, students were generally successful in finding the correct thresholds, but observation of their behavior revealed that some correction of their technique was occasionally needed, and they were occasionally unsure of their procedure.

The feedback consisted of messages displayed on the screen following an error. These messages described the error and stated the procedure that should be used. The review option consisted of a short descriptive paragraph dealing with the different aspects of threshold finding. This option could be accessed at any time during testing, and allowed the student to branch back to the summary program in Unit 2 if he desired.

Examples of the programing of the preceding units are provided in Appendix D.

Method of Evaluation

For the most part, each subject using the audiometer provided information on how well the program taught, and data for further modifications of the program. Thus, continual minor changes were made in the program during subject trials. (This is a unique feature of computer-assisted instruction, and one which was necessarily exploited). Most changes consisted of changing the wording in some textual passages to improve clarity, adding opportunities for review of material, and correcting errors in coding.

One member of the project staff sat with every subject during the tryouts to observe, but he could provide assistance if absolutely necessary. This was considered desirable because of the added information and insight that can be gained from comments by the student during the course and from observing the student's actions. It also facilitated rapid course modifications. Although the student records that can be retrieved from CAI are exceptionally complete, it required about a week to obtain them and they do not show the reason for an error being made by a student. During course development, it is the reason for making an error that is most useful in making corrections. Thus, it is most efficient to ask the student why he entered an incorrect answer at the time the error was made.

All subjects were taught at the Computer Assisted Instruction Laboratory at The Pennsylvania State University. They were all volunteers and were not paid. In most cases it was possible for them to finish in one session. Most subjects were run while few others were signed on the system. This was done by utilizing evenings and weekends.

The relevant characteristics of all subjects are given in Table 2. Students enrolled in the course "Introduction to Audiology" (X1 through X7) were used for the initial course tryouts. These students had had introductory lectures on audiometric testing and had used a portable audiometer to test a few friends with normal hearing. One subject with no audiological background but with experience in writing CAI programs and two nurses with little audiological knowledge also participated in the initial tryouts in order to evaluate the program with subjects who had not used an audiometer.

Subjects with a variety of backgrounds were used for the final tryouts. It would have been desirable to use students in the introductory course, but it was not offered during that term. Consequently, it was decided to obtain subjects with varying backgrounds to provide as complete a test of the course as possible. Seventeen additional subjects were obtained. Of these, three were not able to complete the course due to technical and rescheduling difficulties. Of those who finished, four had completed an introductory course in audiology, three had more extensive practice with audiometry, two had very brief exposure to audiometry, and five had no experience.

RESULTS

Statistical Results

A summary of student performance on the program is given in Table 3. The mean time to complete the program was 131.9 minutes, the median was 133.7 minutes, and the spread was from 84 minutes to 195 minutes. Unit 1 required an average of 36 minutes, Unit 2 took 66 minutes, and Unit 3 took 30 minutes.

Latency data were obtained for each student. Latency is the time it takes a student to make a response to a computer output. These data were obtained for all entries which required a meaningful response; latencies for page turning responses and internal adjusting responses following errors were not recorded. An analysis of individual student records indicated that the latency of a response was almost always shorter than the actual time between the previous response and the one analyzed. This difference was due to processing time, and was of the order of 1/2 to 1 second in most cases. The total latencies for the subjects were not correlated with the total completion times, however, possibly because of

Table 2

Characteristics and Relevant Background of Students

Student Number	Age	Occupation	Sex	CAI Experience	Audiometric Experience	Notes
X1	20	SPA[1] student, 9th term[2]	F	None	Moderate[3]	
X2	20	SPA student, 6th term	F	None	Moderate[3]	
X3	20	SPA student, 8th term	F	None	Moderate[3]	
X4	20	SPA student, 7th term	F	None	Moderate[3]	
X5	20	SPA student, 9th term	M	None	Moderate[3]	
X6	21	SPA student, 8th term	F	None	Moderate[3]	
X7	21[4]	SPA student, 6th term	F	None	Moderate[3]	Indian student
X8	27	Mathematics teacher	M	Extensive	None	CAI Lab staff member
X9	31[4]	Nurse	F	None	None	
X10	24	Nurse	F	None	Slight intro.	
X11	35[4]	Speech and hearing therapist	F	None	Moderate	Did not finish
X12	35[4]	Speech and hearing therapist	F	None	Extensive	
X13	37[4]	Nurse	F	None	None	
X14	23	SPA student, graduate	M	None	Moderate-Extensive	
X15	20[4]	SPA student, 9th term	F	None	Extensive[5]	
X16	20[4]	SPA student, 8th term	F	None	Extensive[5]	
X17	20	SPA student, 9th term	F	None	Extensive[5]	
X18	25	Nurse	F	None	None	
X19	20	Rehab. Ed. student, 9th term	M	None	Extensive[5]	
X20	42	Mathematics teacher	F	Extensive	None	CAI Lab staff member
X21	20	Liberal arts student, 6th term	F	Limited	Slight	
X22	25	Nurse	F	Limited	Slight	
X23	25	Secretary	F	None	None	Did not finish
X24	20[4]	Human Development student, 7th term	F	None	None	
X25	40[4]	Superv., Speech and Hearing Clinic	F	None	Moderate-Extensive	
X26	40[4]	Superv., speech program	F	None	Moderate	Did not finish
X27	20	Bus. Adm. student, 9th term	M	None	None	

[1] SPA is Speech Pathology and Audiology

[2] The term system at Penn State has the following class structure: Freshman: Term 1 - 3; Sophmore: Term 4 - 6; Junior: Term 7 - 9; Senior: Term 10 - 12.

[3] Student in speech pathology course that teaches introduction to audiology. Tested limited number of normal people.

[4] Estimated

[5] Completed audiology course

Table 3

Summary of the Total Time for the Course, Time for Unit 3, Ranking of Students on Time, and Number of Visits Needed to Complete the Program

Student Number	Total Program Time (min.)	Rank	Time for Unit 3	No. of Times On Line
X1	90	2	Incomplete	1
X2	138	14	52	1
X3	148	18	34	1
X4	105[1]	4	No Record	1
X5	106	5	24	1
X6	142	16	30	1
X7	120	8.5	21	1
X8	133	12	40	3
X9	134	13	20	1
X10	170	23	38	1
X11	Incomplete			1
X12	140[1]	15	23	1
X13	125[1]	10.5	22	1
X14	155[1]	20	19	1
X15	120[1]	8.5	21	2
X16	110	6	17	1
X17	84	1	17	1
X18	160	21.5	42	2
X19	95[1]	3	16	1
X20	125[1]	10.5	39	1
X21	150[1]	19	38	1
X22	195[1]	24	64	2
X23	Incomplete			2
X24	160[1]	21.5	No Record	1
X25	115[1]	7	28	1
X26	Incomplete			1
X27	145[1]	17	32	1
Totals	3156		635	
Mean	131.9		30.2	

[1] Timed by observer

differences in reading rates, in break periods (which were not recorded) and in review options selected. Due to these difficulties, latency measures were not included in the performance summary.

The ranking indicates that there is little relationship between the student's position in the sequence and the time he took for task completion. The other differences that may contribute to these differences are discussed below.

Most of the subjects were able to complete the program in one session. System difficulties or time limitations were the cause of two or more visits. Two subjects who were not able to finish in one session were not able to return. One attempted to take the program during the work day but did not finish when little progress was made due to usage of the system by other authors. This problem is discussed further in Appendix E.

Table 4 is a summary of student performance on Units 1 and 2. The enter and process (ep) instruction tells the computer to wait for an input from the student. The number of ep's given in Table 4 does not include page turns, corrective responses, tone duration practice, or tone releases. Unit 3 was omitted from this tally because the free response capability did not allow a test for correctness for every response.

The attempt ratio (AR), calculated by the formula $100 \times \frac{\text{Attempts - ep's}}{\text{ep's}}$, is analogous to an error rate, but attempts may include typing errors, poor aiming of the light pen, program and system errors, and other mistakes that are not due to misunderstanding of concepts. These errors that are not related to learning may comprise ten to fifty percent of the wrong entries made, depending upon the care with which the student works and upon the condition of the program. Due to the continuing improvements being made in the program and to a minor but hard-to-find defect in the ATU itself, system errors made more than a minor contribution to the attempt ratio. Thus, the obtained ratios are an overestimate of the actual errors made by the student. That these system errors were reduced through successive improvements in the software and hardware is indicated by the decreasing trend in AR toward the last of the subjects.

In a program of this type, it might be expected that there would be a positive relationship between the time required to complete the course and the number of errors made. From an inspection of the rankings, this correlation is not evident, although any relationship may be masked by differential numbers of system errors.

For the purposes of this course, Unit 3 (left ear threshold) served as a criterion test. During subject trials, this unit was improved more than the others in response to the needs of the students. In order to challenge the students, this ear was quite different from the right ear they had tested in Unit 2. An audiogram with an abrupt drop (Figure 5), in which the thresholds at 4000 Hz and 8000 Hz were significantly higher than at the lower frequencies, was used.

The number of tones given to obtain the complete left ear audiogram varied from 95 to 207, with a mean of 130 and a mode of 134. An analysis of the subjects' performance in finding thresholds is in Table 5. The acceptability of an audiogram was determined by the nature of the errors. Current audiometric practice considers deviations of 5 db from the true thresholds as acceptable and allows one deviation of 10 db. Using these criteria, 16 of the students (70%) produced acceptable audiograms.

Although seven subjects obtained unacceptable audiograms overall, five of these showed improvement with practice, (as did nearly all subjects). The sequence of frequencies tested was 1000 Hz, 2000 Hz, 4000 Hz, 8000 Hz, 500 Hz, 250 Hz, and 125 Hz; the trend toward improvement is obvious. The strong performance on 8000 Hz was surprising but only one threshold value of 75 db was used for all passes across threshold, and the subjects were given hints and encouragement by the staff observer prior to the addition of the hint capability to the program.

The ranking of subjects on the basis of deviation from correct thresholds does not correspond to a large degree with the other rankings obtained. Apparently the time to complete the program or the attempt rate are not related to the performance in finding thresholds. It is also interesting to note that although there was no trend toward improvement in rankings with an increase in subject number, there was only one unacceptable audiogram among the last twelve students who completed the program. Because this group of subjects comprised a good mixture of backgrounds, the indication is that the effectiveness of the program was improved by the modifications.

Table 6 provides data on subjects regarding previous background in audiology. An interesting finding is that 83 percent of subjects with no previous audiometric testing background (excluding nurses) produced acceptable audiograms while only 67 percent of those with a background in audiology did so. The majority of those with an SPA background who obtained unacceptable results were those taking the course at the time; they may have experienced interference from their partially-learned class work.

Table 6 also explores the relationships between the major performance measures of total time and number of attempts for the course and acceptability of audiograms and other possibly relevant characteristics of the subjects, such as age, sex, and experience with CAI. Although the number of subjects is too small to draw firm conclusions, the most interesting finding was that the nurses, as a group, did poorly on the dimensions of time and attempt rate, although they performed adequately on the criterion audiogram. This may be due to the fact that most of the nurses approached the task more cautiously than the other subjects and may, in fact, have had a less relevant background for the mechanical task than those in the "no experience" group.

As expected, all those experienced with CAI finished in the upper half of the group with respect to time because they did not need time to become accustomed to the system.

No other systematic differences emerged from this analysis.

Table 4

Summary of Entries Made, Attempts, Attempt Rate (AR), and Ranking of Students by Attempt Rate

	Unit 1			Unit 2			Combined Totals			
	ep's	Attempts	AR (%)	ep's	Attempt	AR (%)	Total ep's	Total Att.	AR Total	Rank AR
X1	17[1]	20	18	172	197	15	189	217	15%	5
X2	21[2]	24	14	172	228	33	193	252	31	19.5
X3	23[2]	30	30	173	226	31	196	256	31	19.5
X4	-	-	-	-	-	-	-	-	-	-
X5	26[1]	43	65	172	195	13	198	238	20	11
X6	21[2]	23	10	172	202	17	193	225	17	6.5
X7	21[2]	29	38	205	238	16	226	267	18	8.5
X8	21[2]	26	24	173	217	25	194	243	25	16
X9	33	50	52	194	230	19	227	280	23	13
X10	34	44	29	212	263	36	246	307	25	16
X11	-	-	-	-	-	-	-	-	-	-
X12	38	45	18	245	308	37	283	353	25	16
X13	37	45	22	224	279	25	261	324	24	14
X14	38	48	26	217	279	29	255	327	28	18
X15	34	43	26	216	262	21	250	305	22	12
X16	20[1]	28	29	215	292	36	235	320	36	21.5
X17	12[1]	14	17	217	238	10	229	252	10	2.5
X18	39	45	15	246	288	17	285	333	17	6.5
X19	34	35	3	225	251	12	259	286	10	2.5
X20	28	31	11	216	243	13	244	274	12	4
X21	35	42	20	227	269	19	262	311	19	10
X22	36	43	19	228	315	38	264	358	36	21.5
X23	36	46	28							
X24	-	-	-	-	-	-	-	-	-	-
X25	34	37	9	217	236	9	251	273	9	1
X26	36	43	19							
X27	36	48	33	226	262	16	262	310	18	8.5
Sum	710	882		4564	5518		5202	6311		
N	24	24		22	22		22	22		
Mean	29.6	36.8	24%	207.5	250.8	21%	236.0	286.5	21%	

[1] Passed pretest

[2] Records incomplete

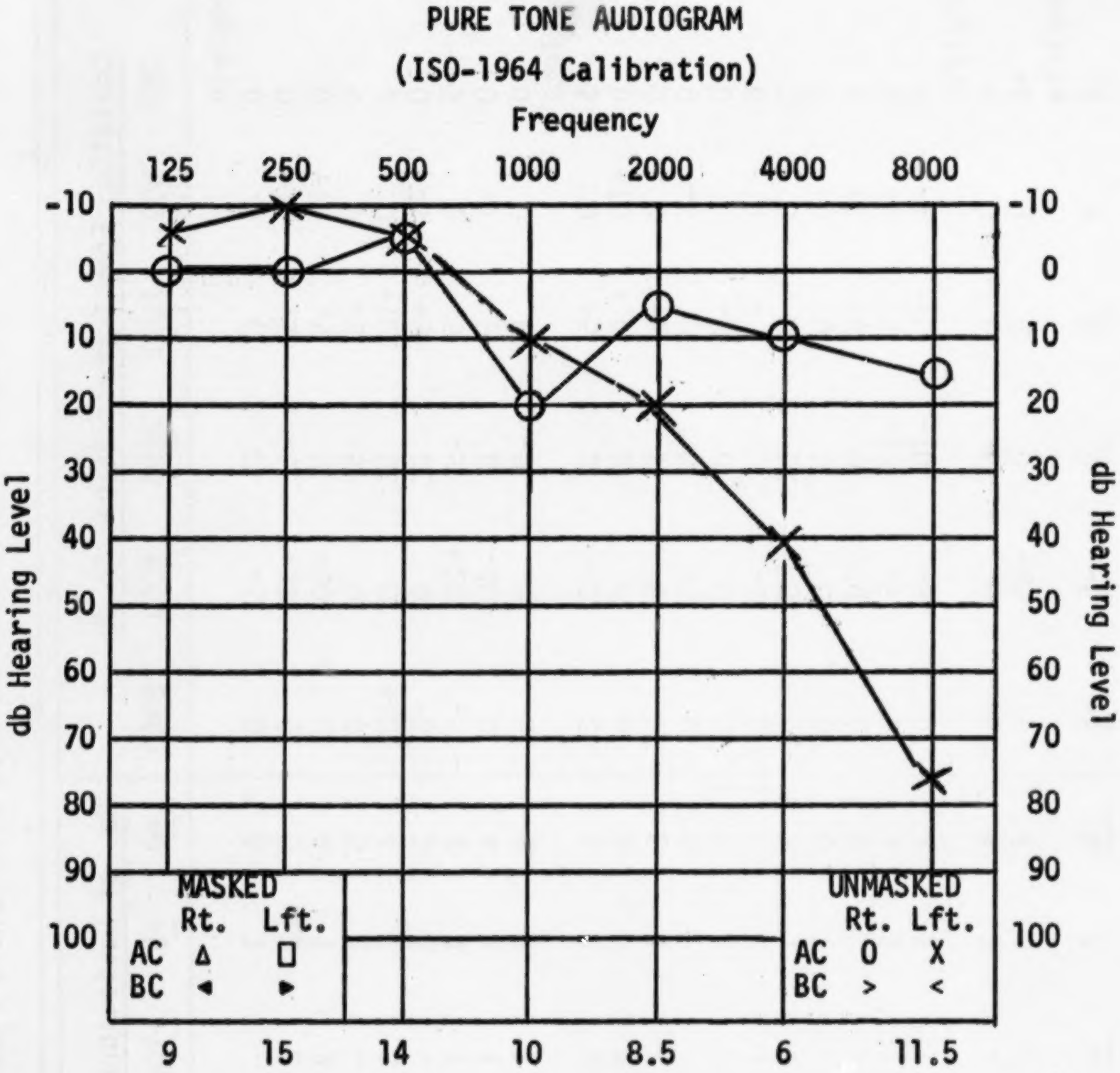


Figure 5. The audiograms for the right ear (Unit 2) and the left ear (Unit 3) of the patient tested by the subjects. (The thresholds for the right ear are indicated by circles, the left ear by crosses).

Table 5

Student Performance on Unit 3 Threshold Finding Task

	Deviation From Correct Value, in db							No. of Deviations			Sum of Absolute Deviations	Rank	Acceptability
	125	250	500	1000	2000	4000	8000	±0	±5	±10+			
X1	Incomplete												
X2	0	0	0	0	0	-5	0	6	1	-	5	3	A
X3	0	0	+10	-5	-5	-35	0	3	2	2	55	23	U
X4	0	0	+10	-5	0	-10	0	4	1	2	25	17.5	U
X5	0	0	0	-5	-5	0	0	5	2	-	10	7.5	A
X6	+10	0	0	+10	0	0	+10+[1]	4	-	3	30	20	U
X7	-5	0	-5	+5	0	0	+5	3	4	-	20	13	A
X8[2]	0	+5	0	-5	-5	-20	-5	2	4	1	40	21	U
X9[2]	0	0	-5	-5	0	-10	0	4	2	1	20	13	A
X10[2]	+15	0	0	0	-5	0	-5	4	2	1	25	17.5	U
X11	Incomplete												
X12	0	+5	0	+5	0	0	0	5	2	-	10	7.5	A
X13	0	0	+10	+15	0	0	0	5	-	2	25	17.5	U
X14	0	0	0	+5	0	0	0	6	1	-	5	3	A
X15	0	0	-5	0	0	-5	0	5	2		10	7.5	A
X16	+5	0	+5	-5	0	0	0	4	3	-	15	10.5	A
X17	0	0	+10	-5	0	-5	0	4	2	1	20	13	A
X18[2]	0	0	0	0	0	0	0	7	-	-	0	1	A
X19[2]	0	0	-5	0	0	0	0	6	1	-	5	3	A
X20	0	0	+5	-5	0	0	0	5	2	-	10	7.5	A
X21[2]	0	0	-5	-5	-10	-5	0	3	3	1	25	17.5	A
X22	0	0	-5	+5	-10	-5	0	3	3	1	25	17.5	A
X23	Incomplete												
X24	-5	0	0	0	-5	0	-5	4	3	-	15	10.5	A
X25	+5	+5	0	0	0	+35	0	4	2	1	45	22	U
X26	Incomplete												
X27[2]	0	0	0	0	0	-5	+5	5	2	-	10	7.5	A
±0	17	20	11	8	16	12	17	101					A = 16
±5	4	3	8	13	5	6	5		44				U = 7
±10+	2	-	4	2	2	5	1			16			

---

[1] Did not find threshold (thought it was above testable range)

[2] Used incorrect symbol for threshold (usually a blue circle)

Table 6

Relationship Between Selected Performance Measures
and Selected Learner Characteristics

Characteristics	Total Time				Number of Attempts				Acceptability of Audiograms			
	N	Upper $\frac{1}{2}$[1]	Lower $\frac{1}{2}$	% Hi	N	Upper $\frac{1}{2}$[2]	Lower $\frac{1}{2}$	% Hi	N	Acc.	Unacc.	% Acc.
Age												
Over 30	5	3	2	60	5	2	3	40	5	3	2	60
Under 30	19	9	10	47	17	9	8	53	18	13	5	72
Background												
SPA	13	8	5	62	12	6	6	50	12	8	4	67
Nurse	5	1	4	20	5	1	4	20	5	3	2	60
No Exp	6	3	3	50	5	4	1	80	6	5	1	83
Sex												
Male	5	3	2	60	5	3	2	60	5	4	1	80
Female	19	9	10	47	17	8	9	47	18	12	6	67
CAI Experience												
CAI	2	2	0	100	2	1	1	50	2	1	1	50
No CAI	22	10	12	45	20	10	10	50	21	12	6	57

[1] Those requiring the least time

[2] Those making the fewest attempts

Observation and Interview Results

After completion of the program, each student was asked to discuss his attitudes and opinions of the course and of CAI as a method of learning. An initial questionnaire consisting of seven questions was used as a basic framework for the discussion, but the subject was encouraged to add anything he wished. The list was later expanded to eleven questions to evaluate added capabilities. The final list of questions is in Appendix G. Questions appropriate to each subject were selected from the list.

The results of the postprogram discussion are given in Table 7. Almost all subjects liked the CAI method of learning. One dissenter thought it was too mechanical, one preferred to learn by listening. Most students (80 percent) preferred practice with the CAI "patient" to practice with live patients for the early stages of training. Those who had worked with live patients pointed out that there are other cues that can be used with people, such as facial expressions, spoken responses, and attentional cues which could not be simulated, but most stated that the man on the display screen was a good approximation of a live patient; he responded about the same. Almost all students recommended practice with live subjects at some point in training; this is assumed to be a necessity for a full course of instruction.

Other questions dealt with specific characteristics of the program and equipment. Most students thought the program was not too difficult. Some complained that terms were used which they did not understand; this led to the addition of an optional vocabulary review. Those students who experienced difficulty provided information for course revisions and the addition of more review options. They generally liked the variety of thresholds and the ATU panel.

To check the accuracy of the course, students with prior audiometric training were asked if the program taught anything incorrectly. All agreed that nothing erroneous was taught, although some said the procedure was different from what they had learned and experienced difficulty following the prescribed technique during the criterion testing. Some students-in-training found that they had forgotten or had not learned some of the details of the threshold finding technique in class.

Perhaps the most interesting result concerned the speed of the program. Although it was self-paced, 25 percent of the students said the course was too fast, 10 percent thought it too slow. Some of those who felt it was too fast specifically referred to Unit 3 in which students were urged to test at a normal testing rate. If a student took too long between entries, a message appeared asking if he was finished. This was perceived by some students as pushing them to perform faster than they wanted. In addition, at other points in the program, messages urging a student to respond could appear if excess time was taken (the "time out" was about twice the average time to answer a question). One student who complained of slowness was on line while other course authors were on line. The resulting degradation of the system did, in fact, cause the program to run slowly. This most seriously effected the speed of the "patient's" response, a problem that was minimized by operating at times others were not on the system.

Students enrolled in the audiology course were asked to compare the CAI method with their class experience. Most thought it was good review and liked the feedback provided by CAI. Two said they learned more in the CAI course, one thought it was harder. One student pointed to the flexibility of review and the possibility of playing games to see what would happen without disturbing a live patient. Another student observed that it made her learn the material.

During audiometric testing both the tone duration and the pause duration are supposed to be within a limited range (2 to 4 seconds). After the first test trials, feedback concerning the pause duration was added to Unit 3 (tone duration was already being displayed). Although some students liked this information, others were distracted by it, so its availability was made optional. The majority of students preferred to work without the pause information although observation indicated that they tended to make the pauses too short.

Many students took advantage of the reviews and other help provided in the course. At least three used the review feature of Unit 2, and at least five selected the option to go through portions of the programed summary more than once. After the review option was added to Unit 3, about one third of the students used it to make sure they were doing the right thing or to check on specific procedures before they started. Almost all students, and all those with no experience, used the vocabulary review option after it was made available in Unit 2. Many students also used the option in Unit 1 to practice giving tones of correct duration.

Six students attempted the pretest which would allow them to skip the introductory part of the course. Five passed it and skipped ahead; one failed. One who passed was the first subject tested, X1, who did not complete Unit 3 because of technical difficulties. The other four required an average of 101 minutes to complete the course, which is markedly below the all-student average of 132 minutes.

Most students with no audiometric experience used the portable audiometer to find out what the tones were like. They had little trouble using it and were able to make use of their learning of the ATU panel for the smaller device. These students generally felt that experience with the real instrument was useful and made the learning more meaningful.

Students generally had little difficulty using the CAI terminal equipment. An introduction to the terminal, which was the first part of Unit 1, was successful in teaching how to make responses with the keyboard and light pen and how to change keyboard responses. Some students had a little difficulty learning how to respond due to the initial strangeness of the process, but these problems were worked out during the introduction. The light pen was usually easy to use except for the audiogram which was placed on the display screen. Fine discriminations with the light pen were needed to indicate the placement of the obtained threshold points on the audiogram; a few subjects had difficulty aiming the light pen properly, but all ultimately succeeded. Helpful messages were displayed when this difficulty was encountered.

Table 7

Attitudes and Comments by Subjects Concerning the Course

Student	Liked Method of Learning	Speed?	Too Difficult?	Prefer CAI to Human Practice	Comments by Subjects and Notes
X1	Y	o.k.	N	N	Thought man to be good approximation of patient, learned as much as in class; liked feedback during practice.
X2	Y	Too Slow	N	Humans	Other programs on at this time; slowed audio too much, good review.
X3	Y	o.k.	Class helped	Y	Prefer learning on computer before humans, needs more practice with tone arm; course explains some points better than class; liked feedback, being told what is wrong.
X4	Not at first	o.k.	Some-times*	CAI more diff.	Didn't understand "Ascending" and "Descending"; needed more time to adjust to system, preferred CAI as supplement after working with humans; harder than regular course, but learned more; did not like regulation.
X5	Very much	Good	N	Y Before humans	Presentation - good; liked being able to go back to areas where he had difficulty; more flexible in class; clearcut; could play games and work out bugs before testing live patients.
X6	Excell	Too fast*	N	Y Before humans	Is slow reader; liked being told tone duration; more thorough than class; good review.
X7	N*	Too fast	Vocab# diff.	Good practice	*Too mechanical. #X7 a foreign student, language problems? Liked knowing right and wrong answers and tone duration; "It made you learn it." Complained of being tired.
X8	Y	N	N	As practice	Should allow more time of left ear instead of asking if finished.
X9	Y	Slow*	N	Y	Need for background in what you're doing. This is good for manipulating the audiometer. *First part too slow.

X10	Y	o.k.*	N	Before humans	*Speeded up at end; display at pause duration distracting; would like to hear tone.
X11	Incomplete				
X12	o.k.*	Too fast	N#	N	Prefer practicing on humans due to other "clues"; facial expressions, speaking to patient, etc. *Rather learn by listening. #Sometimes confusing.
X13	Y	o.k.	N	Y	Thought the program provided better practice than would humans.
X14	Y	Too fast	N	Both# variety	#Good for technique, but needed human. Include fact that testing humans is different.
X15	Y	Too fast*	N	Y	Would want some practice on humans too; why have and mention (on panel) the parts of the audiometer that aren't used in the course. *Left ear too fast.
X16	Y	Fast*	N#	Before humans	Liked working privately and getting feedback, flickering screen annoying. *S fatigued #Had difficulty timing tones.
X17	Y	Good	N	Both	Liked being able to control course speed - "enjoyed" course.
X18	Y	o.k.	N*		New experience, enjoyed it. *Confusing at start (especially entering, etc.) but learned.
X19	Good	Good	N	Y	Liked being able to go over things when needed; interesting being on.
X20	Y	Right	N	Before humans	Forced to concentrate; program more free of bugs than other she's been on.
X21	Y	Right	N	Both	Good method for this type of course.
X22	Y	o.k.	*	Humans	*Didn't know what to do when left on her own.
X23	Incomplete				
X24	Y	Good	N	Before humans	Enjoyed experience; thought CAI better than class, could review, not bored; didn't think slides of panel necessary; did better than she expected.
X25	Y	Good	N	Y*	Liked program because S could control speed; CAI practice more difficult than humans. *Difficult at first.
X26	Incomplete				
X27	Y	o.k.*	N	Both	Felt she could now test humans. *Regulated speed.

Students were not usually disturbed by the occasional system errors which occurred such as errors in timing of the tone duration, program errors, or erroneous feedback resulting from hardware difficulties with the tone switch. However, the reasons for errors were explained to the students when they did occur, and the number of errors was improved from about three percent of responses at the start of trials to about zero percent at the end. Errors mostly occurred when others were on the system, especially when authors were working on line. In two cases it was necessary to pause in the program until others were finished, and one student who could only work during office hours could not complete the program due to system usage by others. A more complete discussion of these difficulties is given in the conclusions and in Appendix E.

The best evaluation of what was learned from the program can be gained from looking at the specific procedures used by students to obtain the thresholds in Unit 3. These were obtained from the students' records. Representative samples are provided in Appendix H.

A review of the procedures used found that although no student used the correct procedure for all thresholds, most used a method that was basically correct for most of the thresholds. The most difficulty was experienced with the 4000 Hz and 8000 Hz frequencies which differed from previous experience in that the thresholds were significantly higher than previous frequencies. Most errors consisted of not completing a third, descending pass across threshold when the need for one was indicated. Other errors included testing at one db level more than once successively, starting a descending pass by using the wrong db increment and not adequately completing a pass across threshold. However, these errors still allowed an estimate of threshold that was close to the correct one. The use of review and the error messages, which were added for the last six subjects, resulted in an improvement in the methods used.

A comparison of the techniques used with the errors made indicates that for most of the gross errors (more than 10 db), the correct information was available. It may be that in some cases the error was made in marking the audiogram form itself, or due to a faulty memory. This type of error should decrease with practice.

The sequence in which the frequencies were tested was generally correct, although two students omitted one frequency, one tested the higher frequencies in the wrong sequence, and one tested two frequencies twice.

CONCLUSIONS

Based on the results, the audiology program generally succeeded in bringing students to the stated criterion behavior of using the method of limits to find hearing thresholds. It is significant that the same level of proficiency was reached by students with such a wide variety of backgrounds and experience and that there was little systematic difference in time taken or attempt rate between those who had experience in audiometry and those who had none. These results may be primarily attributed to the capability of CAI for self-pacing, feedback, branching, and student-selected review or repetition. The use of self pacing was certainly shown by the variation in times to complete the program. Slow readers or those initially unfamiliar with audiometry could take their time and be sure they understood each frame, while those who were experienced in audiometry or who could work quickly were able to speed through the program at a rate they found most comfortable. However, the inherent time lags in Units 2 and 3 slowed down those students with prior audiometric experience who tended to test a subject too rapidly and made them aware of their tendency to work too quickly.

Feedback, about which most students made favorable comments, can be a very powerful capability of CAI and was apparently used effectively in this program. Unique uses of feedback included telling the student which switch on the ATU was set wrong and how it was set, the duration of tones and pauses, and unit summaries of the types of errors made with the ATU. Students were almost always required to make a correct response before they were allowed to continue with the program. A variety of messages were provided for each response opportunity so that a message appropriate to each specific error could be displayed. In this way the course was tailored to each individual. For this reason, also, the size of step could be made larger than in a comparable linear program, with the consequence of a higher error rate. That students with high attempt rates performed well on the criterion audiogram attests to the fact that this method produces effective learning.

Feedback telling the duration of each tone was appreciated by almost all students. Those taking the course in audiometry remarked that it was the first time they knew how long their tones were, and to some of them it was a surprise. However, one or two experienced audiologists complained that the computer generated times were incorrect, although most durations were accurate to one third of a second. Occasional errors in timing did occur which may have lessened confidence in this feedback; this problem is discussed in Appendix E.

Due to the nature of the material and the large step size, true branching within the course usually occurred under student direction, for example, the pretest option and the review, practice, or repetition options were true branches. Recommendations for review were made if a student's performance was less than a specified minimum, but the final choice lay with the student. Students did use these choices wisely, however, as indicated by the number that selected more work on a topic. If they were confused or felt that they had not learned adequately, they selected appropriate reviews. This implies that students can be trusted to make effective learning decisions during a course, and they seem to appreciate being able to choose. It may give them a feeling of control over the course rather than a feeling that they are stuck in a mechanical sequence about which they can do nothing. This feeling of control may have contributed greatly to the favorable attitude expressed toward the course.

The favorable attitude and the rapid pace of the course may explain the students' ability to work continuously for over two hours, even though rest periods could be selected at the end of each unit. Some students were continuously absorbed with the task and did not stop until they were finished. Those who required much more than two hours tended to tire somewhat; the older women tended to become fatigued after two hours. It was found that students who left the program in the middle and returned after one or more days had little difficulty continuing. Thus, in operational use it is suggested that students work in increments of not more than two hours.

It was decided that about two hours was all that could reasonably be asked of unpaid volunteers and that adequate information on course effectiveness could be gained from the left ear audiogram (Unit 3). The full course consists of nine more full (both ear) audiograms, but more can be generated easily by making a small number of changes in a deck of punched cards. Based on the obtained times for Unit 3, it is anticipated that additional simulated audiograms would require a little less than an hour each, although this time should decrease with practice. These times compare favorably with the reported time of one hour to test a live subject. The added audiograms contain different patterns of hearing loss (flat, marked downward slope, trough, etc.) as well as special deviations from the patterns (abrupt drop, notch, etc.) which have been drawn from actual clinical records. Included within the simulated audiograms are such transient auditory phenomena as temporary threshold shift, loss of attention, and patient fatigue. With these the student would receive a thorough introduction to the various kinds of hearing difficulties he might encounter in basic audiometric testing and would be much better prepared for them than if he had tested only normal subjects. The need for practice in transient auditory phenomena was vividly illustrated by those students in audiology who had a great deal of difficulty finding the left ear thresholds for 4000 Hz and 8000 Hz. They had never encountered such a situation and did not know how to proceed.

The difficulty experienced by students with the first few frequencies of Unit 3, and their subsequent improvement, highlighted the need for extensive practice in audiometry. Although the required skills of using a specific procedure to change db level, timing of the tone duration, and remembering obtained estimates of threshold seem fairly simple individually, students had difficulty integrating them as a unit, even after extensive practice with the mechanical skills. They frequently complained that they couldn't remember the obtained thresholds of a frequency. Some students even wrote down the results of each hearing level as they tested. It was necessary for them to experience a "real" testing environment and work with it in order to develop the required unified skills needed by a good audiometrician. This experience can be gained much better in a CAI environment that can provide feedback, or can give assistance if requested, than by a live subject who may become impatient to do other things and can give no help concerning the accuracy of the procedures involved. When the student has completed his training with CAI he is fully prepared to learn the subtleties of working with live patients and need not be concerned with the fundamental techniques of testing.

Simultaneous usage of the computer by students working on other courses usually made little impact on the audiometry program, but use of other terminals by authors inputting, revising, or testing material usually slowed the response of the displayed "patient", sometimes so severely that a student would be finished giving the tone before the "patient's" hand was raised. The amount of system degradation depended upon the number of authors working and the type of work they were doing. One author who was only executing material slowed the system occasionally; this could usually be tolerated and a few students ran under this condition. Two students attempted to work during heavy system usage; one could not complete the program, the other finished during a less busy time.

As a test of interference, two staff members operated the audiometry program simultaneously as students, one using the ATU and the other using a typewriter to simulate the ATU. Little interference resulted from this test, even when the two "students" were working at different points in the program.

Program interference due to system usage is not usually a problem with courses, but due to the need for rapid response time for effective simulation, system degrading is an important factor in the audiometry course. Thus, it will be most effective when no others are using the computer, and can be operated successfully when other students are taking a course that involves relatively simple operations.

The 1500 System instructional terminal proved to be an effective medium for instruction. The display screen, which was used for most of the communication, was generally adequate although some students complained of flickering and some suffered eye fatigue from the quality of the light. The size of the screen restricted the amount of text that could be displayed at one time, and limited the types and extent of feedback messages. However, this limitation has the advantage of minimizing the amount of text that can be presented to a student at one time and promotes economical use of verbal messages.

The image projector provided the capability for showing photographs of the ATU on which specific settings could be shown and highlighted to be used as remedial or corrective material, photographs of a "patient" with earphones placed correctly and incorrectly, full color reproductions of the audiogram forms for comparison and for text to be used as a reference or a message while other material was displayed on the CRT. The projector was in general, satisfactory, although it was found that the initial exposure of film was critical and difficulties were encountered with the reproduction of the film (discussed in Appendix E). Film is very useful when photographs or diagrams are needed for the instruction or when some reference is to be used for more than one display. However, these could also be placed in a loose-leaf booklet, although directions to the page would be required. The major disadvantage of film is the need to completely rephotograph all images if one change is to be made. Thus, it may be preferable to use loose-leaf booklets for initial tryouts of images and make the film only when all images are finalized. It was also found useful to make multiple exposures of each image to insure at least one good frame of each. Because of some initial difficulty with the camera used to photograph the images, this precaution proved a valuable one.

Coursewriter II generally was able to meet the demands made upon it, but some of the instructions were found to interfere with the timing process used and, at times, the limited logical capabilities required that complex coding be used to perform a simple logical branch. A discussion of programing with Coursewriter II is given in Appendix E.

RECOMMENDATIONS

Although the audiometry program and the Audiometer Trainer Unit works well, some modifications to the ATU that would simplify the program coding and produce a more efficient and faster course, have been found to be desirable. Some kind of signal that differentiates between depression and release of the tone switch is needed to insure that the computer stays in phase with the student (due to the freedom given the student in Unit 3, it is possible for the student to work so fast that a depression of the tone switch is treated as a release - the computer gets out of phase). The most needed modification is a timing mechanism built into the ATU to measure the duration of the tone switch depressions. This would allow completely accurate timing that is not subject to interference by other computer users. This time could be transmitted to the computer upon release of the tone switch.

A recommended addition to the course, which was commented upon by some students, is the use of audio messages. The IBM 1506 audio units furnish a random-access audio playback capability. These units were installed near the end of the project and could be used to play the tones given by a student, to give examples of other audiometer outputs (SISI, tone warble, etc.), and to direct audiometer operations which wouldallow the student to pay full attention to the audiometer and relieve him from the process of reading and then operating. The addition of audio messages would require some course revision, but the improvement in the course would be worth the effort.

With the development of the ATU and the success of the basic audiometry program, it would now be feasible to extend the program to include more advanced audiometric techniques such as the SISI test, the loudness balance test, the use of masking and the use of tone warble. However, some further modifications of the ATU may be necessary. A treatment of various pathological conditions could be integrated with further practice in audiometry to provide added experience in dealing with "patient" responses that are typical of different types of audiological involvement. This would permit the advanced training of audiologists in an enviornment closely approximating reality, where they test a "patient," make a preliminary diagnosis, seek further information if necessary through specialized testing, make a final diagnosis, and finally make recommendations. This environment is difficult to obtain in the real word because of the limited number of people with pathological auditory conditions and the reluctance of testing centers to allow novice audiologists to work with those that are available.

Although the expansion to a more sophisticated course is one recommended continuation of the present project, there are many uses to which the present course could be put. It was, of course, designed to be used as a part of a college course in audiology. However, its success with audiometrically naive students indicates that it could be used as a stand-alone course for the training of nurses, technicians, and others who need only a basic knowledge of audiometry. The emerging mobile CAI concept, in which a computer and terminals are mounted in vans which can be easily moved to different locations, would allow school and industrial nurses and others normally responsible for giving screening audiograms to take the course to maintain their proficiency for administering full hearing tests. Such a concept could also allow the teaching of audiometry to disadvantaged persons near their homes to give them a skill that may be in more of a demand than those they possess.

Experience with the trained audiometricians indicates that proficiency maintenance would be a good application of the program. Although some experienced audiologists went through the whole course to see what it was like and a few passed the pretest, others felt that they needed to go through the material again. The average attempt rate of this group indicates that some relearning was needed, although the techniques taught by this course may have differed somewhat from those originally learned. Perhaps the group that would be helped most by such proficiency maintenance methods would be those such as school nurses who spend most of their time giving screening audiograms. Although none of this group could be obtained for the trials, the results indicate that they could benefit from this program.

The results of this study may be considered in contexts other than that of audiometry. The successful integration of the audiometry simulator with an instructional computer system indicates that other devices could also be simulated, such as a polygraph, EKG and EEG Units, anesthesia administering units, and other devices that are commonly used with people and for which patients with pathological conditions are not available for practice. However, this concept need not be applied only to patient contact devices. Instruction in the use of any equipment that requires adjustment to specific conditions, such as x-ray equipment, various patient monitoring devices, artifical hearts, lungs, and kidneys, and even commonly used laboratory equipment could be provided through interfacing an appropriate simulator with a computer system such as the 1500. One application of this type to electronics, the use of a multimeter, has been described and tested by Rivett (1967).

The feasibility of using a computer-controlled simulator of a patient contact device for the training of device operators has been demonstrated by this project. The future is limited only by the ingenuity required to design and build effective simulators. The use of CAI with simulators that require hands-on experience is postulated as one of the most valid and defensible uses of CAI because training in the use of devices such as an audiometer by any other means cannot be as effective as that provided by CAI.

REFERENCES

Lewis, B. N. and Pask, G. The theory and practice of adaptive teaching systems. In Glaser, R. (ed.), *Teaching Machines and Programed Learning, II*. Washington, D. C.: National Education Association, 1965.

Peloquin, P. V. 1500 System geometric dictionary. In Mitzel, H. E. and Brandon, G. L. *Experimentation With Computer-Assisted Instruction in Technical Education*, Semi Annual Progress Report. Report No. R-11, contract No. 5-85-074, June 30, 1968.

Rivett, R. C. *Computer Assisted Training Simulators and the Multimeter Trainer Unit*. Gaithersburg, Md., IBM Corp., Federal Systems Division, May 5, 1967.

Swets, J. A. and Feurzeig, W. Computer-aided instruction. *Science*, 1965, 150, 572-276.

Uttal, W. R. On conversational interaction. In Coulson, J. E. (Ed.), *Programmed Learning and Computer-Based Instruction*. New York: Wiley and Sons, 1962.

APPENDIX A

Audiometer Trainer Unit
Theory and Maintenance Instructions

Audiometer Trainer Unit

Theory and Maintenance Instructions

Developed pursuant to subcontract
OEG-TPSU-4586-01
with
The Pennsylvania State University
under a grant from the
U. S. Office of Education
Department of Health, Education, and Welfare

August 1968

Federal Systems Division
INTERNATIONAL BUSINESS MACHINES CORPORATION
Gaithersburg, Maryland

FOREWORD

This manual describes the Audiometer Trainer Unit (ATU) and its operation with both the 1050 and the 1500 Instructional System. It is designed to be used as a guide in maintaining the unit.

CONTENTS

Page

INTRODUCTION 1

DESCRIPTION 1

INTERFACE 3

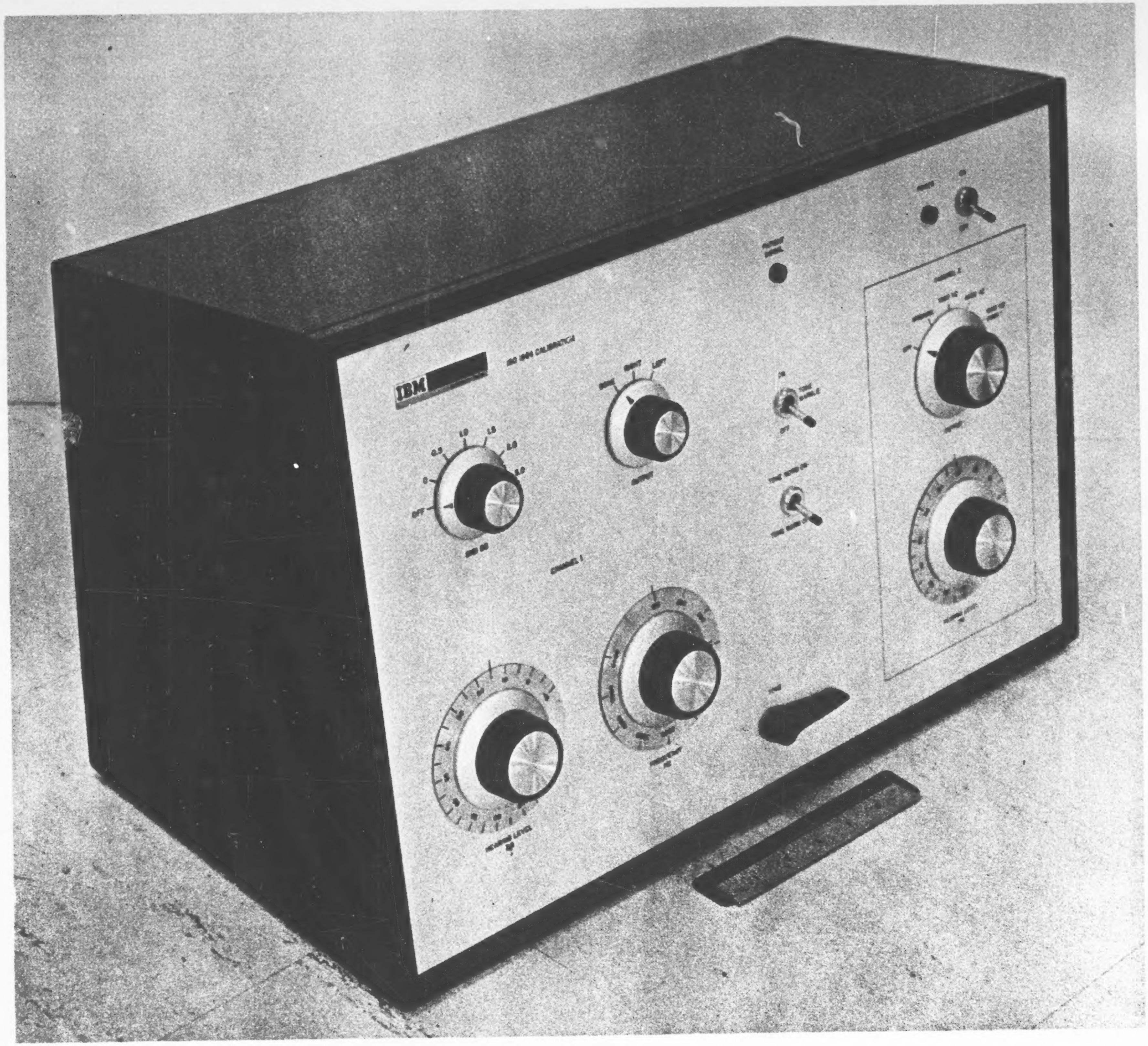
1050 OPERATION 3

- ATU Control 3
- Scan Cycle 8
- EOB Operation 11

1500 OPERATION 17

- Scan Cycle 19
- Transmit Cycle 22

BIBLIOGRAPHY 23



Audiometer Trainer Unit

INTRODUCTION

The IBM Audiometer Trainer Unit (ATU) is a unique device which applies Computer Assisted Instruction (CAI) to laboratory exercises or "hands-on" training in Audiology. For this training, the student must perform practical exercises on an audiometer, a device used to test a patient's hearing.

In learning to operate and perform hearing examinations with the audiometer, subjects must be available to act as patients. In audiology classes these "patients" are other students of the class whose hearing is usually normal.

The ATU, operated in conjunction with a CAI program in Coursewriter language, provides step-by-step instruction in the operation of audiometers without the necessity for an instructor's continual checking or testing of performance. The CAI program is written to simulate the "patient" under examination; therefore, the student may be presented with hearing characteristics representing any abnormalities desired. Even audiometer malfunction can be simulated.

DESCRIPTION

Audiometers are presently built by several manufacturers; the design depends on whether the device is for use in schools as a screening device, for use in clinics and hospitals, or for more specialized examinations. Outwardly, the ATU is representative of audiometers in general use. (Figure 1) It has dials, switches, etc. similar to the standard American pure-tone audiometers. Dial labeling, knob size, etc., represent the generally accepted practice in the field.

Transition from the ATU to an actual audiometer should be no more difficult for the student than the transition from the audiometer of one manufacturer to that of another.

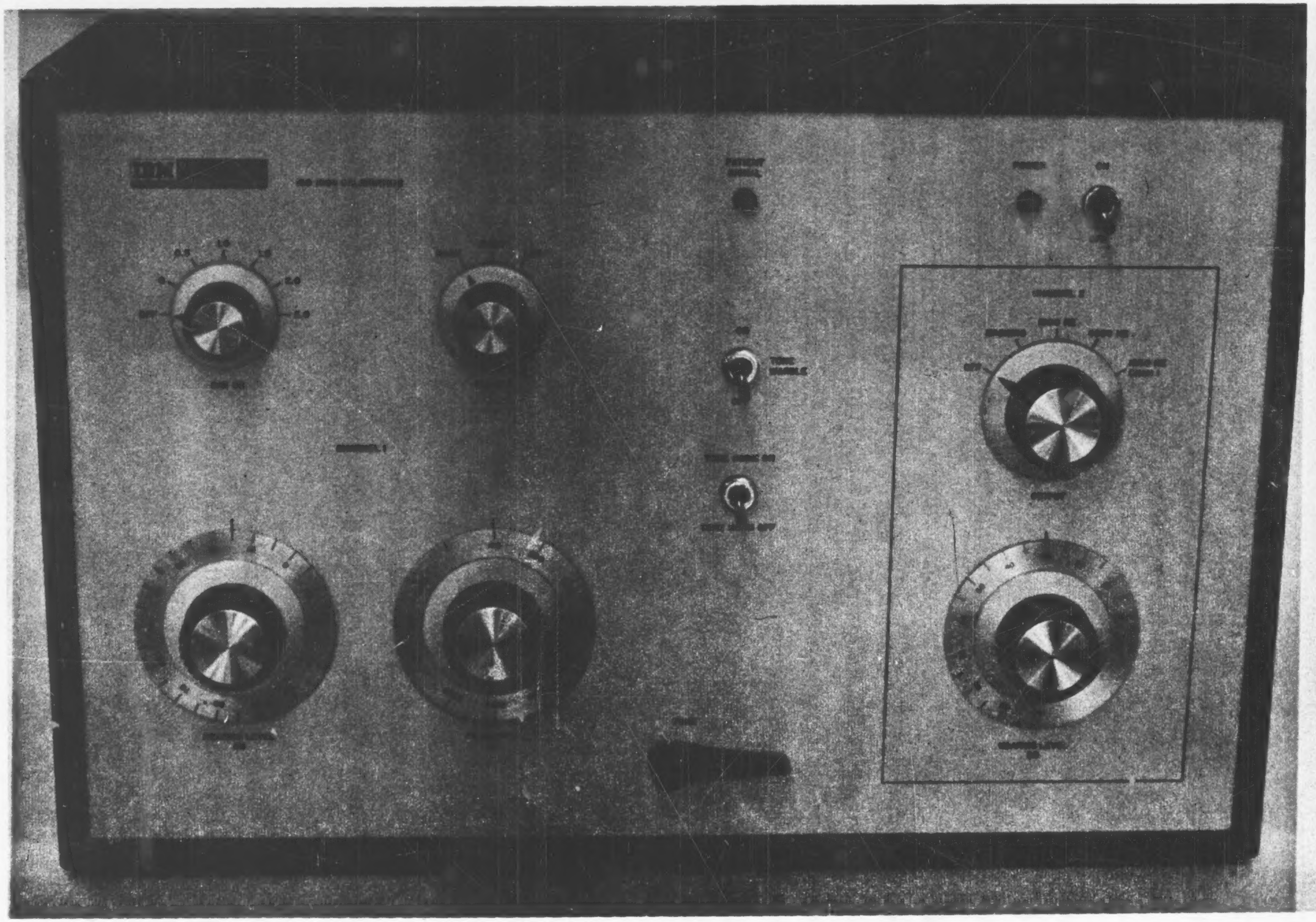

IBM
0
0.5
1.0
1.5
2.0
3.0
OFF
CHANNEL 1
PATIENT SIGNAL
ON
TONE ENABLE
POWER
ON
CHANNEL 2
OFF

Figure 1. Audiometer Trainer Unit, Front Panel

Internally, the ATU contains none of the tone-generating and control functions found in actual audiometers. It contains instrumentation for encoding the switch positions as well as controls and interface circuitry to supply the computer with these positions.

INTERFACE

Although the ATU has a single front panel design, the internal subchassis installed within the unit depend on whether it is to be used with the 1050 System or the 1500 System. When the ATU is interfaced with the IBM 1050 Data Communication System, the internal circuits of the ATU are similar to those of the IBM 1092 Programmed Keyboard. When connected to the IBM 1500 Instructional System, the ATU contains circuits which make its operation similar to that of the IBM 1518 Typewriter and Control Unit.

1050 OPERATION

The ATU is attached to the 1051 control unit of the 1050 System by one cable which carries data, control signals, and power. Figure 2 is a block diagram showing elements of the ATU when used for 1050 operation. Pressing the TONE switch causes a relay contact to close. When the 1050 polls the ATU, the contact is sensed and relay circuits activate a mechanical scanner (Figure 3) which samples front panel switch positions.

As each switch is scanned, its position is encoded in binary-coded decimal by a diode-coding matrix, and it is sent to the 1051 on seven bit-parallel lines (six BCD bits plus parity). Coding for each switch is shown in Figure 4. At the end of the cycle, an End-of-Block (EOB) character is transmitted.

ATU CONTROL

a. The ATU initiates and ends transmissions.
b. When the 1050 is ready to read, scanning begins.
c. At the end of the scan cycle, the 1050 indicates the receipt of a good transmission.

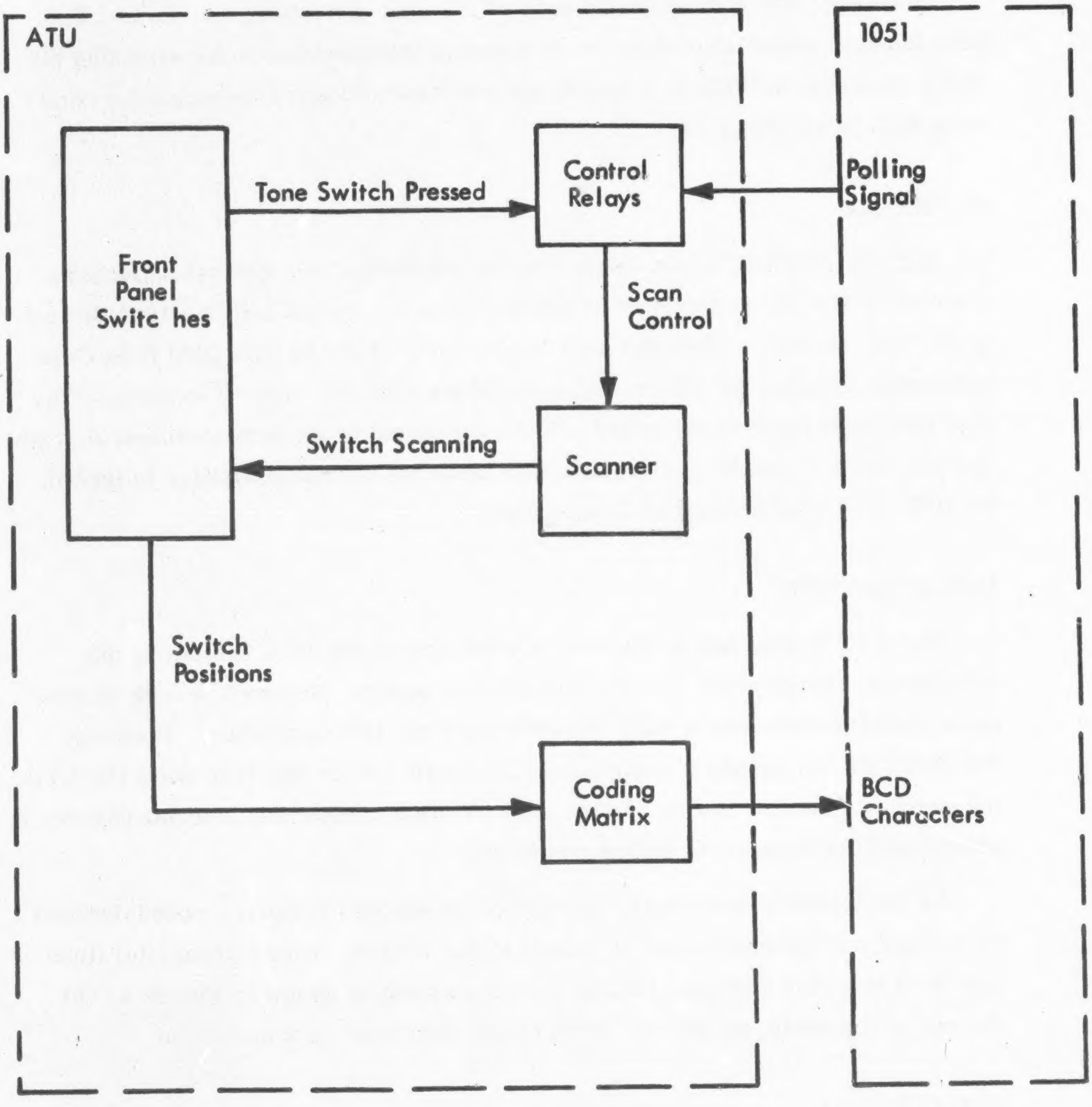

ATU
1051
Front Panel Switches
Tone Switch Pressed
Control Relays
Polling Signal
Scan Control
Switch Scanning
Scanner
Switch Positions
Coding Matrix
BCD Characters

Figure 2. ATU/1050 Block Diagram

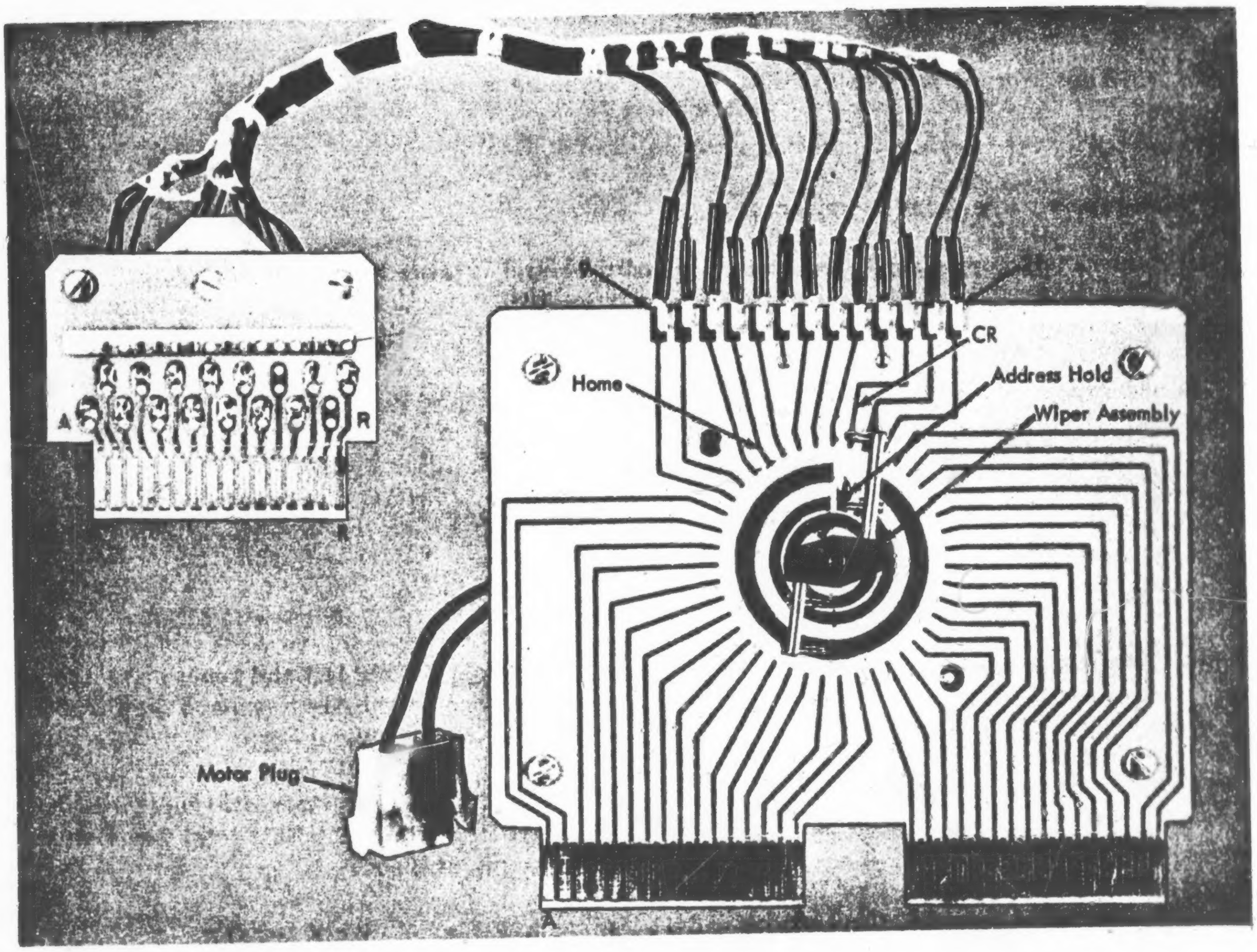

CR
Home
Address Hold
Wiper Assembly
Motor Plug
A
R
A

Figure 3. Scanner Card (1051 Attachment)

CHARACTER SWITCH	ALPHAMERIC CHARACTER																									1050 CODE							1500 CODE					
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	1	2	4	8	A	B	C	1	2	4	8	A	B
CS1 HEARING LEVEL (CH.2) (DB)																																						
0	X																										X		X			X	X	X		X		
5		X																								X							X	X	X	X	X	X
10			X																								X						X	X	X		X	
15				X																						X	X					X						
20					X																							X					X	X		X		X
25						X																				X		X				X	X	X	X	X		
30							X																															
35								X																		X	X	X					X	X	X	X		X
40									X																				X				X	X	X			X
45										X																X			X				X	X				
50											X															X				X	X			X	X			X
55												X															X			X	X		X					
60													X													X	X			X	X	X						
65														X													X			X	X		X		X	X		X
70															X											X	X			X	X	X	X		X	X		
75																X											X	X		X	X	X			X		X	X
80																	X									X	X	X		X	X				X	X	X	X
85																		X											X	X	X		X			X		
90																			X							X			X	X	X	X		X	X			
95																				X						X					X	X			X	X	X	
100																					X						X				XX				X			
CS2 TONE WARBLE																																						
ON	X																										X	X				X	X	X		X		
OFF		X																								X							X	X	X	X	X	X
CS3 TONE																																						
NORM ON	X																										X	X				X	X	X		X		
NORM OFF		X																								X							X	X	X	X	X	X
CS4 SISI (DB)																																						
OFF	X																										X		X			X	X	X		X		
0		X																								X							X	X	X	X	X	X
0.5			X																								X						X	X	X		X	
1.0				X																						X	X					X	X	X	X		X	X
1.5					X																							X					X	X		X		X
2.0						X																				X		X				X	X	X	X	X		
5.0							X																				X	X				X	X	X	X			
CS5 OUTPUT																																						
RIGHT		X																								X							X	X	X		X	
LEFT			X																								X						X	X	X	X	X	X
BONE	X																										X		X			X	X	X		X		
CS6 OUTPUT (CH.2)																																						
OFF	X																										X		X			X	X	X		X		
MASKING		X																								X							X	X	X	X	X	X
1000 HZ			X																								X						X	X	X		X	
4000 HZ				X																						X	X					X	X	X	X		X	X
(CH.1) 1000 HZ					X																							X					X	X		X		X

Figure 4. ATU Switch Coding (Sheet 1 of 2)

CHARACTER	ALPHAMERIC CHARACTER																									1050 CODE							1500 CODE					
SWITCH	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	1	2	4	8	A	B	C	1	2	4	8	A	B
CS7 HEARING LEVEL (DB)																																						
-10	X																										X		X			X	X	X		X		
-05		X																								X							X	X	X	X	X	X
0			X																								X						X	X	X		X	
5				X																						X	X					X	X	X	X		X	X
10					X																							X					X	X		X		X
15						X																				X		X				X	X	X	X	X		
20							X																				X	X				X	X	X	X			
25								X																		X	X	X					X	X	X	X		X
30									X																				X				X	X	X			X
35										X																X			X			X	X	X				
40											X															X				X	X			X	X			X
45												X															X			X	X		X					
50													X													X	X			X	X	X	X		X			X
55														X														X		X	X		X		X	X		X
60															X											X		X		X	X	X	X		X	X		
65																X											X	X		X	X	X			X		X	X
70																	X									X	X	X		X	X				X	X	X	X
75																		X											X	X	X		X			X		
80																			X							X			X	X	X	X		X	X			
85																				X						X					X	X			X	X	X	
90																					X						X				X	X	X		X			
95																						X				X	X				X		X			X		X
100																							X					X			X	X		X	X	X	X	X
105																								X		X		X			X		X		X		X	
110																									X		X	X			X			X		X		X
CS8 FREQUENCY (H2)																																						
BLANK	X																										X		X			X	X	X		X		
125		X																								X							X	X	X	X	X	X
250			X																								X						X	X	X		X	
500				X																						X	X					X	X	X	X		X	X
750					X																							X					X	X		X		X
1000						X																				X	X					X	X	X	X	X		
1500							X																				X	X				X	X	X	X			
2000								X																		X	X	X					X	X	X	X		X
3000									X																				X				X	X	X			X
4000										X																X			X			X	X	X				
6000											X															X				X	X			X	X			X
8000												X															X			X	X		X					

Figure 4. (Sheet 2 of 2)

The ATU, as an input to a 1050 system, is similar to a 1092 matrix keyboard. As such, the ATU must be selected by the 1050. The ATU first indicates that it has data ready to transmit. Then, when the 1050 indicates that it is ready to accept data from the ATU, a scan operation begins. The scan cycle (14.8 cps) sequentially transmits BCD data to the 1051, representing all the data prewired in the ATU switches.

The scanner card (Figure 3) controls the order and speed at which the data is transmitted. The order is determined by jumper wires; the speed by the speed of the synchronous motor. A wiper assembly, connected to the motor shaft, makes one revolution on each scan cycle. As the wiper rotates, it electrically connects +12 volts to each data segment. Each data segment except the last one in the scan cycle is wired to the common contact of a front panel switch. The contacts of each front panel switch are connected to the coding matrix, which produces BCD code for the switch setting. The last data segment in the scan cycle is wired to produce the BCD code for EOB.

SCAN CYCLE

a. The ATU indicates that the data is ready.
b. The 1050 indicates that it is ready to transmit from the ATU
c. The scan cycle begins.
d. The switch position data is transferred to the 1050 parallel by bit, and serial by character.
e. An EOB character signals the end of a single transmission.

Description

Before a transmission can be requested, power must be supplied by the 1051 through a connection at the reader interface. The power switch on the ATU controls only dc power; ac power for the scanner motor, supplied from the 1051, is not switched. Each time power is initially applied to the ATU, the scanner motor advances to the home position. This is called power-on homing and is not a true scan cycle, because the correct operating procedures have not yet been put into effect.

Power-on homing is performed by picking the homing relay through a N/C power-on point and holding it until the home position on the scanner is reached.

Pressing the tone key picks the ready relay and activates the paper contact line to the 1051. The ready relay holds until a good answer is received at the end of the transmission. When polling determines that the paper contact line is active, the 1051 activates the reader-clutch line to pick the address relay. The address relay pick-coil is under the direct control of the 1050 reader-clutch line. The hold coil is used to ensure a complete transmission of a character if the 1050 drops the reader-clutch line in the middle of a character transfer.

The address relay and the ready relay pick the motor relay and a scan cycle begins. The first step on the scanner is not used with the ATU.

Each character is transmitted in the same manner. The selected character is first encoded to BCD (Figure 4) and applied to the bit lines which are connected to the 1050. Any BCD bit picks the strobe relay. This relay activates the strobe line to indicate to the 1050 that data is on the bit line(s). The 1050 uses the strobe line to gate the BCD data to the line - or home-register.

The strobe relay also picks the strobe duration relay to govern the length of the impulse. The strobe duration relay is conditioned by an R/C network to slow the pick and provide the timing for the strobe impulse. When the strobe duration relay picks (R/C network timed out), the end-data relay picks to drop the strobe relay. The end-data relay holds to the end of the scanner segment. When the end-data relay drops, the same operation can be repeated for the next character.

Circuit Objectives

All logic locations are for 92A07 unless otherwise noted.

1. Power-on homing.
    Pick homing relay (5-2 N/C, C2-Power On point).
    Run motor (6-3 N/O, C1).
    Pick home relay (home step, C2).
    Pick power-on relay (F2).
    Drop homing relay (5-2 N/C, D2-Home point).
    Stop motor (6-3 N/O, C1).
2. Set Front Panel Switches
3. Indicate ready-to-transmit to the 1050.
    Press the TONE key (C1).
    Pick the ready relay (7-3 N/C, D1).
    Activate paper contact line (3-2 N/O, B1).
4. Run the scanner motor.
    This operation sequentially reads out the switch position codes.

Each scanner step transmits a character in the same manner, up to the EOB step. See EOB operation.

Pick the address relay (reader clutch line from 1050, D1).

Pick the motor relay (2-1 N/O, 3-3 N/O, D1).

Run the scanner motor (4-1 N/O, E2).

5. Prefix Code Step (No transmission in ATU application)
    Pick prefix relay (prefix step, F1).
    Hold prefix relay (1-1 N/O, 2-2 N/C, 5-1 N/O, F1).

6. Encode a character to BCD.

   Example: switch 3 (channel I hearing level) in position 3

   Activate scanner common (2-2 N/O, 92A08, A1).

   Wiper moves to position B024.

   +12 V to C04C on logic 92A02, A1.

   Switch 5 N/O to D01H on logic 92A07, A1.

   Encode C, 4, 1 (A1).

7. Transmit a character.

   Data on bit lines (from encoder, A1 and 2).

   Pick strobe relay (BCD data, 5-4 N/O, 3-3 N/C, B1).

   Activate strobe line to 1050 (6-1 N/O, B1).

   Pick strobe duration relay (6-3 N/O, B2).

   Pick end-data relay (2-1 N/O, B2).

   Pick end-of-prefix relay (3-4 N/O, 1-4 N/O, F2).

   Drop strobe relay (3-3 N/C, B1).

   Drop strobe duration relay (6-3 N/O, B2).

   Drop end-data relay (no data on bit lines, B2).

EOB OPERATION

a. The EOB step on the scanner transmits an EOB character (C, B, 8, 4, 2).

b. The EOB step also picks the homing relay to advance the scanner to the home position.

c. The good-answer relay must pick before a new transmission can be requested.

d. Three modes of operation control the pick of the good-answer relay:

   Home-loop

   Line-loop without error correction

   Line-loop with error correction.

Home-Loop (Figure 5)

Home-loop would be used with the ATU only for test; it is used with the 1092 Keyboards for communication between output units.

The EOB step on the scanner picks the homing relay. In home-loop mode, the 1050 does not drop the reader-clutch line so the motor is controlled by two circuits: ready and address and the homing relay.

The ready relay drops when the good-answer relay picks. The homing relay keeps the motor running until the scanner reaches the home position.

The step following the EOB step picks the good-answer relay to drop the ready relay.

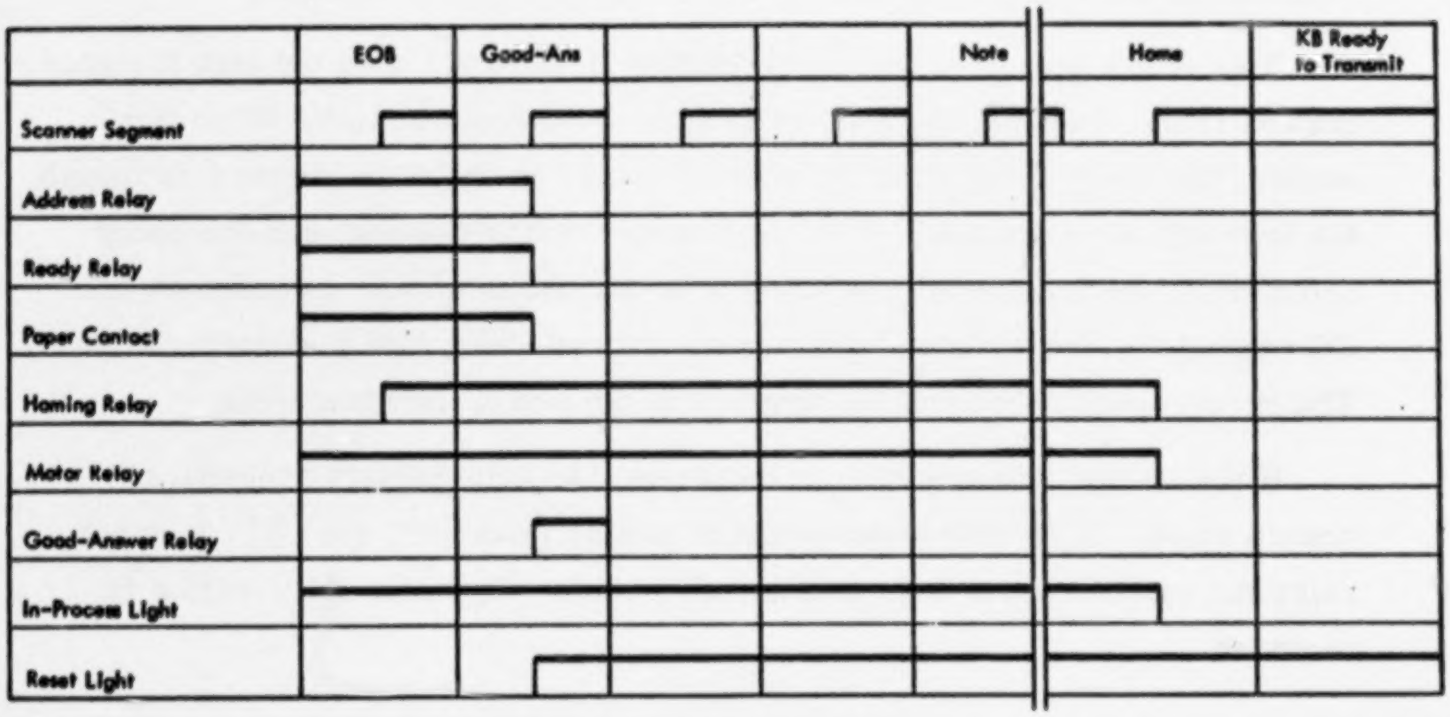
Line-Loop without Error Correction

This operation is similar to home-loop except that the 1050 drops the reader-clutch line when the EOB character is received, and initiates an error check. Two operating conditions are then possible:

1. The 1050 receives a good-answer Y and raises the reader-clutch line. If the scanner has reached the home position, a new transmission can begin.
2. The 1050 receives an error answer N. The 1050 does not raise the reader clutch, and a new transmission cannot occur. Operator intervention is required. This indication is displayed on the 1050. The control of the good-answer relay and the homing relay is identical to home-loop operation.

Line-Loop with Error Correction

The EOB character indicates the end of a group of data, and the 1050 initiates an error check. The EOB step also picks the homing relay to advance the scanner to the home position. This much of the operation is identical to home-loop. The major difference with the error correction feature on the 1050 lies in the control of the good-answer relay.


EOB
Good-Ans
Note
Home
KB Ready to Transmit
Scanner Segment
Address Relay
Ready Relay
Paper Contact
Homing Relay
Motor Relay
Good-Answer Relay
In-Process Light
Reset Light

Note: This gap is variable, depending on whether a single or tandem installation is used.

Figure 5. Home-Loop

When the 1050 initiates the error check, two operating conditions are possible:

1. The 1050 receives a good-answer Y .
2. The 1050 receives an error answer N .

If a good-answer is received (Figure 6), the 1050 picks the good-answer relay through a N/O good-answer-gate relay point. If the scanner has reached the home position, ATU is ready for a new transmission.

If an error answer is received (Figure 7), the 1050 does not pick the good-answer relay. Instead, the 1050 raises the reader-clutch line. When this occurs, the ready relay runs the scanner motor in the same manner as though the tone key were pressed. With the scanner motor running, and the ready and address relays picked, the same data is retransmitted. In addition, the CR segment on the scanner activates the reread-reset line to restart the 1050. The error-check procedure is repeated at the end of the scan cycle.

If the second transmission is incorrect, the auto-restart procedure occurs again. If the third transmission is also incorrect, the 1050 does not raise the reader-clutch line, and the ATU stops. Operator intervention is required.

Circuit Objectives

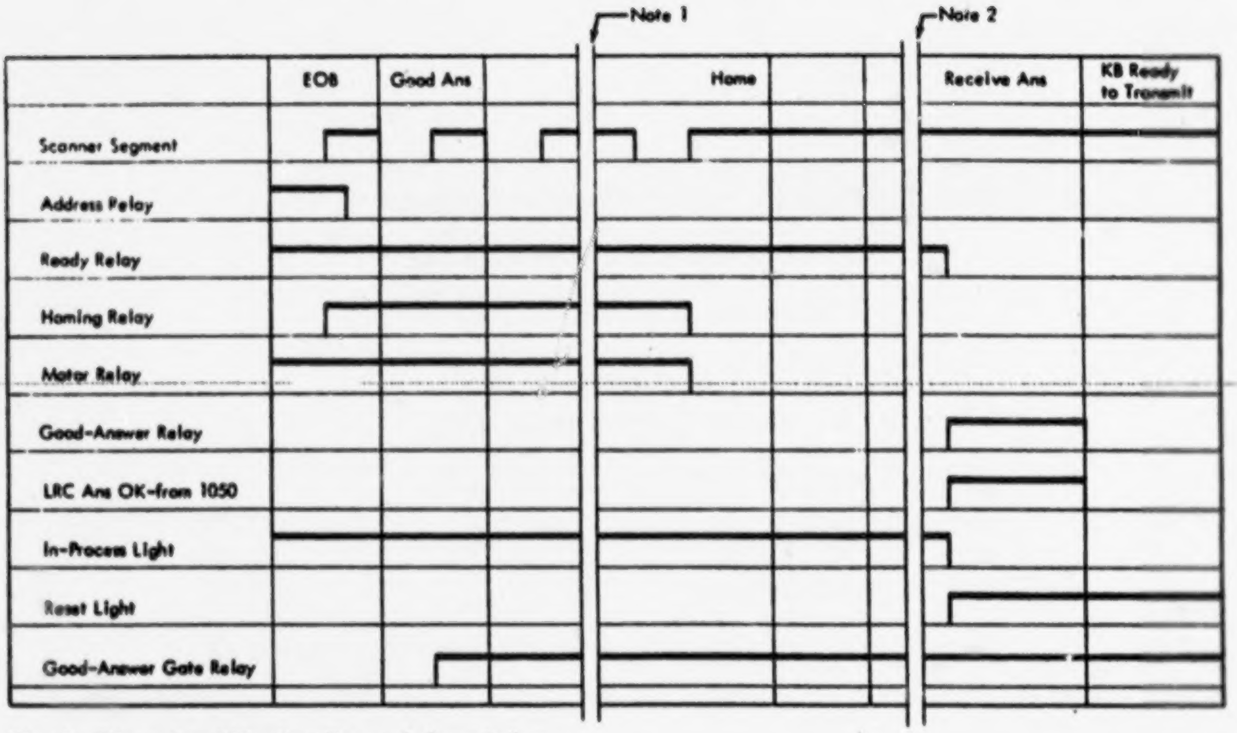
All logic locations are for 92A07 unless otherwise noted.

1. Home-Loop
    a. Transmit EOB character (C, B, 8, 4, 2).
        EOB step on scanner (92A08, A2).

        Signal feeds through 92A07, C2 and D2, to 92A07, A2.

        Encode EOB character on bit lines (A2).

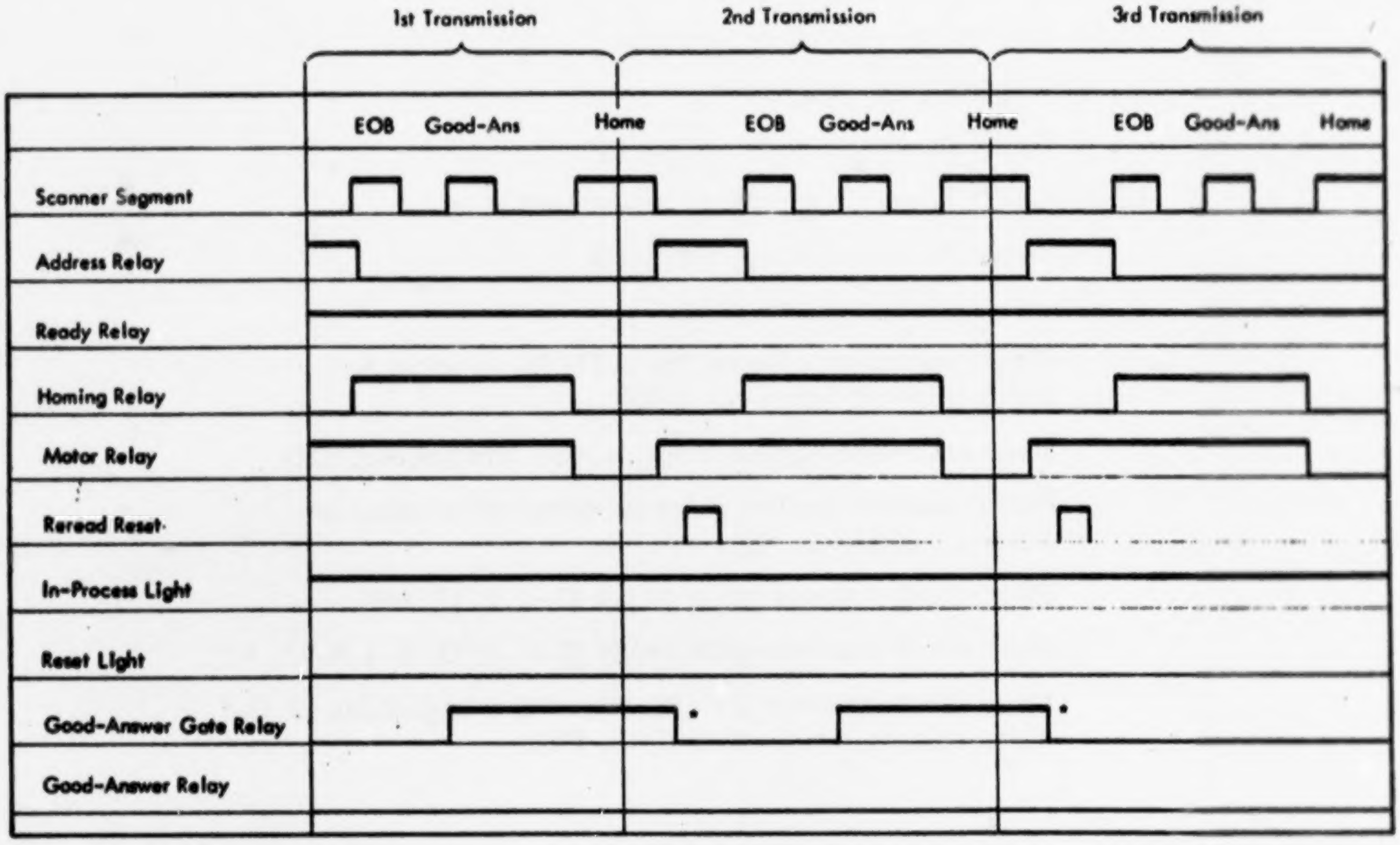
        Transmit EOB character.


Note 1
Note 2
EOB
Good Ans
Home
Receive Ans
KB Ready to Transmit
Scanner Segment
Address Relay
Ready Relay
Homing Relay
Motor Relay
Good-Answer Relay
LRC Ans OK-from 1050
In-Process Light
Reset Light
Good-Answer Gate Relay

Note 1: This gap is variable, depending on whether a single or tandem installation is used.

Note 2: This gap is variable, depending on 1050 turn-around time. This gap can occur before the keyboard reaches the home position.

Figure 6. Line-Loop with Error Correction—No Error


1st Transmission
2nd Transmission
3rd Transmission
EOB
Good-Ans
Home
EOB
Good-Ans
Home
EOB
Good-Ans
Home
Scanner Segment
Address Relay
Ready Relay
Homing Relay
Motor Relay
Reread Reset
In-Process Light
Reset Light
Good-Answer Gate Relay
Good-Answer Relay
*
*

* Dropped by end-of-prefix relay.

Figure 7. Line-Loop with Error Correction—Error

b. Advance scanner motor to home position

EOB step on scanner (92A08, A2).

Pick homing relay (5-2 N/C, A2).

Hold motor relay (6-3 N/O, D1).

Pick home relay (home step, D2).

Drop homing relay (5-2 N/C, D2).

Drop motor relay (6-3 N/O, D1).

c. Force a good-answer

Good-answer without error-correction step on scanner (92A08, A2).

Pick good-answer relay (1-2 N/C, D2).

Drop ready relay (7-3 N/C, D1).

2. Line-Loop without error correction.

In the ATU there is no difference between this operation and home-loop operation. In case of an error transmission, the 1050 drops the reader-clutch line to force operator intervention before another transmission can take place. The error is signaled on the 1050.

3. Line-Loop with error correction.

a. Transmit EOB character.

Same as home-loop, item 1A.

b. Advance scanner motor to home position.

Same as home-loop, item 1B.

c. Develop good-answer gate.

This operation allows the ATU to receive a good-answer from the 1050.

Pick line-correction relay (1050 controlled, D2).

Good-answer without error-correction step on scanner (92A08, A2).

Pick good-answer gate relay (1-1 N/O, D2).

Hold good-answer gate relay (3-2 N/O, 5-1 N/O, F2).

Drop good-answer gate relay at the beginning of the next transmission (2-2 N/C, F2).

d. Pick good-answer relay.

This operation is under control of the 1050.

LRC answer OK from 1050 (C2).

Pick good-answer relay (3-1 N/O, LRC OK, D2).

1500 OPERATION

For 1500 operation, the ATU has its own 12 volt dc power supply. Line power is supplied by a power cable (110 volt ac) and is switched by the POWER switch on the ATU. Connection to the 1500 system is through the 1052 Station Control in the same manner as other devices (i.e., a cable connects the ATU to the Input-Output Data Bus (IODB), the Device Selection Bus, and the Examine Bus).

Figure 8 is a block diagram of the ATU when used with the 1500 System. When the TONE switch is pressed, the ATU control circuits cause the Ring Counter to scan to the first switch position in the scan cycle. Output from the first scanner position sets the Program Call Bit (PCB) latch. This is sensed when the ATU is polled in the 1502 examine cycle, informing the 1500 that the ATU is ready to send data. The 1502 initiates a fetch cycle via the appropriate select lines of the Device Selection Bus. The position of the first switch is encoded in correspondence code by the Diode Coding Matrix and sent to the 1502 Input-Output Data Register. Switch coding is shown in Figure 4. The FETCH signal is also used to reset the PCB latch and step the Ring Counter to the next ATU switch position.

The Ring Counter output sets the PCB latch again so that another PCB is sensed when the ATU is polled during the next examine cycle, starting another fetch cycle. This cycle scans the second switch position and sends the coded position to the 1502.

This process is repeated until all eight switches are scanned. No EOB character is transmitted; the Coursewriter programmer must specify in the ep instruction (which requests a response from the ATU) that eight characters is the maximum to be accepted in order to cause forced generation of an EOB.

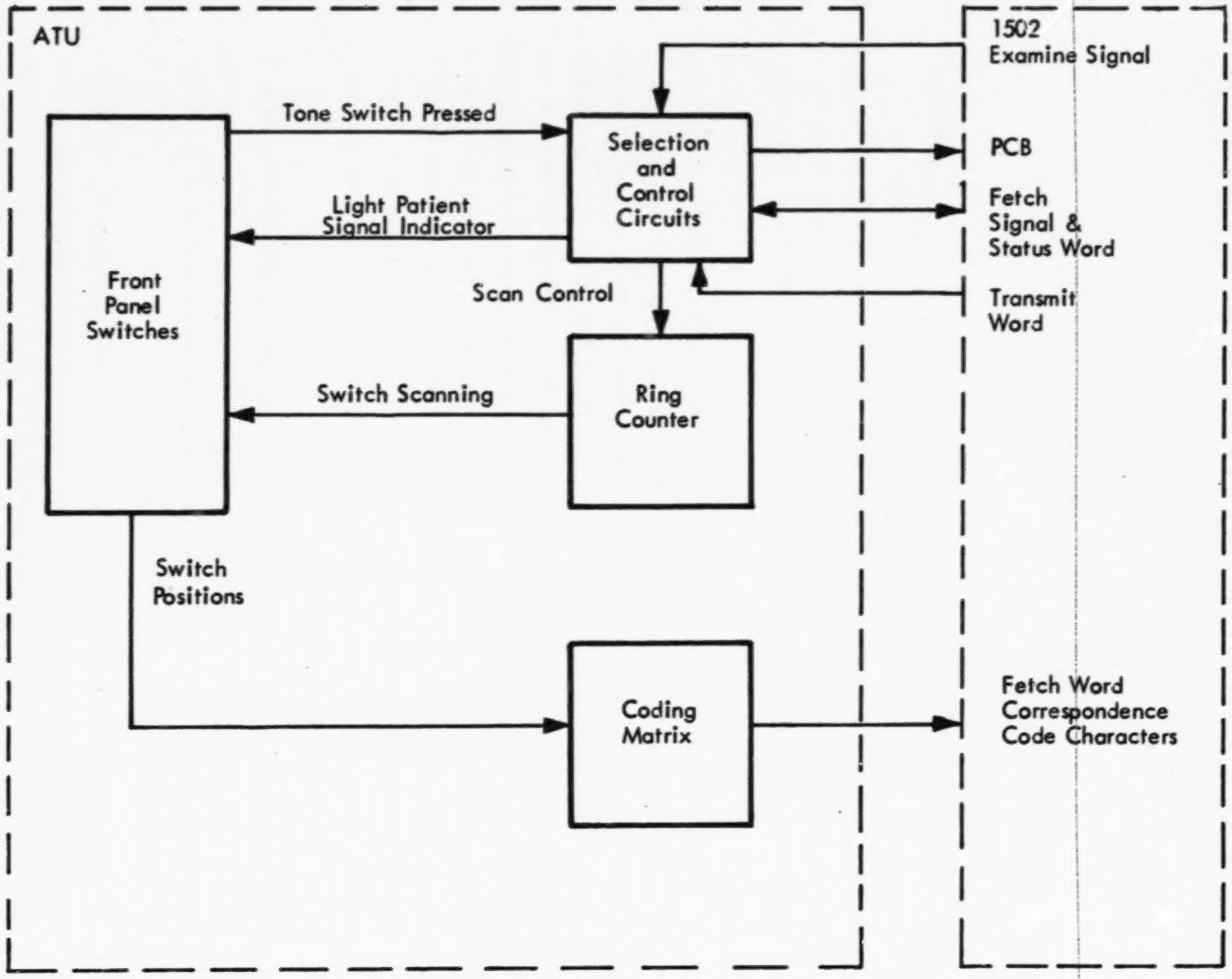

ATU
Front Panel Switches
Tone Switch Pressed
Light Patient Signal Indicator
Selection and Control Circuits
Scan Control
Ring Counter
Switch Scanning
Switch Positions
Coding Matrix
1502
Examine Signal
PCB
Fetch Signal & Status Word
Transmit Word
Fetch Word Correspondence Code Characters

Figure 8. ATU/1500 Block Diagram

The switch position codes are placed in bit positions 10-15 of the Input Data Word to the 1502. Only three other bits of this word are sent by the ATU: Bit 1 (Unit Operation) indicates the 12-volt power is available; Bit 4 indicates that a PCB was present (data ready) at the start of the current fetch cycle; Bit 2 performs the following function. To satisfy 1518 I/O device routines under which the ATU operates, the keyboard lock function of the 1518 is simulated. While performing no mechanical locking, a latch is provided to accept keyboard lock-bits from the IODB interface during the transmit cycle. As a result, a 2 bit is made available to the IODB interface to indicate the mode (keyboard locked).

The PATIENT SIGNAL indicator on the ATU is controlled by a latch that is set by utilizing an output or print operation. A ty Coursewriter instruction is used to set or reset the latch by typing a b (bit 10) or w (bit 11) respectively.

SCAN CYCLE (See Schematics)

During the first examine cycle after ATU power is turned on, all flip-flops in the Ring Counter are reset. The Counter consists of nine flip-flops. The first flip-flop stays in the reset state throughout the scan cycle, gating the second flip-flop so that a trigger input can only reset it. The remaining eight flip-flops each supply 12 volts when set to the common terminal of one of the eight front panel switches which are scanned.

Each flip-flop except the first and last gates the next flip-flop in the Counter sequence in the following way: If a flip-flop is set, the next flip-flop is gated so that a trigger input can only set it. If a flip-flop is reset, the next flip-flop is gated so that a trigger input can only reset it.

Pressing the TONE switch grounds the input to an invertor (logical 0), producing 12 volts at the invertor output (logical 1). This output is AND'ed with a NOT KEYBOARD LOCK, and a NOT BLOCK START signal from the Examine Card. The NOT BLOCK START signal prevents the initiation of a scan cycle prior to the completion of a fetch cycle which may be in process.

The AND'ed output sets the TONE switch latch, which remains set until the TONE switch is released. Release of the TONE switch repeats the input operation in its entirety to provide a capability for course authors to record how long the switch is held down.

The TONE switch latch output triggers a single-shot, producing a one-millisecond pulse which is inverted and sets the Switch 1 Flip-Flop in the Ring Counter. The Switch 1 Flip-Flop has three outputs. The first gates the Switch 2 Flip-Flop so that a trigger will set it. The second supplies 12 volts to the common terminal of Switch 1. The 12 volts goes to the Diode Coding Matrix through a line which depends on the switch setting. The switch setting is encoded by the matrix and placed on the IODB during the fetch cycle.

The third output of the Switch 1 Flip-Flop is OR'ed with the outputs of the remaining switch flip-flops (all in reset state), AND'ed with a NOT DELAYED ADVANCE signal, and applied to the PCB latch, setting it.

Setting of the PCB latch brings up the PROGRAM CALL line which goes to the Examine and Fetch Cards. The Examine Card generates a BLOCK START signal which keeps the TONE switch latch from being initially set if an examine or fetch cycle is in process.

When the ATU is polled during the next examine cycle, the presence of PC CALL and EXAMINE signals at the input to the Examine Card causes a PCB to be put on the Examine Bus, IGSB, to the 1502, informing the 1500 CPU that the ATU has a character to send.

When the 1500 CPU selects the ATU for a fetch cycle, the X-SELECT and Y-FETCH SELECT lines to the Fetch Card are brought up. This, along with POWER ON and PC CALL signals, causes the fetch card to place the coded Switch 1 character on the IODB to be sent to the 1502. The FETCH signal triggers the PCB latch reset single-shot and all the Ring Counter flip-flops. It is also inverted and applied to the ADVANCE line.

The single-shot resets the PCB latch with a 10 microsecond pulse. The ADVANCE signal prevents the PCB latch from setting again by triggering a four millisecond single-shot holding down the NOT DLYD ADV to the AND gate. This is to permit processor time of the fetch word.

When the trigger input generated by the FETCH signal reaches the Ring Counter flip-flops, they are all in the reset state except the Switch 1 Flip-Flop, which was set when the TONE switch was pressed.

As described above, each flip-flop is gated so that it will be reset by a trigger input unless the previous flip-flop in sequence is in the set state. Therefore, the trigger sets the Switch 2 Flip-Flop, resets the Switch 1 Flip-Flop, and leaves the remaining flip-flops in the reset state. Now, only the Switch 2 Flip-Flop is set.

Setting of the Switch 2 Flip-Flop places 12 volts on the common terminal of Switch 2, causing the Switch 2 position to be encoded by the Coding Matrix and made available to the fetch card. The Switch 2 Flip-Flop also sets the PCB latch through the SCANNER 2 line when the four-millisecond NOT DLYD ADV from the single-shot ends. This again generates a PC CALL signal so that a PCB will be sent to the 1500 in the next examine cycle, indicating that the ATU is ready to send another character in response to a fetch cycle.

The next fetch cycle sends the Switch 2 coded position and steps the ring counter in a similar way to position 3. Each switch position is sent in turn until completion of the fetch cycle for Switch 8 position. After Switch 8 is sent, the PCB latch is not set because all of the Ring Counter flip-flops are reset. Following a forced EOB, caused by the ep instruction calling for 8 characters, the I/O device routine requires a final program call. This is done by setting the Scan End latch when the Switch 8 position is reached. This and the DLYD ADV signal then set the PCB latch.

TRANSMIT CYCLE

When Bit 10 of the data word is present during a transmit cycle, the Patient Response latch is set through the Xmit Card, lighting the PATIENT SIGNAL indicator. The indicator remains lit until a Bit 11 is sent by a Coursewriter ty instruction (w character). This resets the latch, turning off the indicator.

BIBLIOGRAPHY

1. IBM 1500 Operating System, Computer-Assisted Instruction, Coursewriter II (CAI-4036)

2. IBM 1500 Instructional System, System Summary (CAI-4038)

3. IBM 1500 Instructional System, System Configurator (CAI-4041)

4. IBM 1130 Computing System Principles of Operation (A26-5881)

5. IBM 1500 Instructional System, Introduction to Computer-Assisted Instruction and System Summary (Y26-5610)

6. IBM 1500 Coursewriter II Author's Guide, Part I: Course Planning (Y26-5570)

7. IBM 1500 Coursewriter II Author's Guide, Part II: Course Program Development (Y26-5681)

8. IBM 1500 Instructional System, Computer-Assisted Instruction, Student's Guide (Y26-5796)

9. IBM 1500 Instructional System, User's Guide, Station Commands (Y26-5788)

10. Procedures for Transmitting/Receiving Messages between an IBM Data Processing System and a 1050 Data Communication System (C20-1664)

11. IBM 1050 Operator's Guide (A24-3125)

BIBLIOGRAPHY

This is a list of manuals that contain information of value in servicing the Audiometer Trainer Unit.

Manual Name	Type	Form Number
IBM 1130 Computing System, Functional Characteristics	SRL	A26-5881
IBM 1130 Computing System	FETO	Y26-5978
Includes: IBM 1131 Central Processing Unit		
IBM Disk Storage Feature		
IBM 1130 Computing System, Features	FETO	Y26-3670
Includes: IBM 1442 Card Read Punch Feature		
IBM 1132 Printer Feature		
IBM 1627 Plotter Feature		
IBM 1134/1055 Paper Tape Reader-Punch Feature		
IBM 1130 Computing System	FEMM	Y26-5977
IBM 1130 Computing System	IPC	127-0808
I/O Printer (Modified IBM SELECTRIC)	FE	225-6595
I/O Printer (Modified IBM SELECTRIC)	FEMM	225-1726
IBM 1130 Reference Card		X26-3566
Solid Logic Technology Packaging	FETO	Y22-2800
Tektronix Oscilloscopes	FETO	223-6725
Transistor Component Circuits	FETO	223-6889
Transistor Theory Illustrated	FETO	223-6794
Transistor Theory and Application	FETO	223-6783

BIBLIOGRAPHY (Concluded)

Manual Name	Type		Form Number
SLT Power Supplies	FETO	. . .	223-2799
IBM 1500 Instructional System	FEMDM	. . .	Y26-4142
IBM 1502 Station Control	FETO	. . .	Y26-3689
IBM 1502 Station Control	FEMM	. . .	Y26-4012
IBM 1510 Instructional Display	FETO	. . .	Y26-3691
IBM 1510 Instructional Display	FEMM	. . .	Y26-4013
IBM 1518 Typewriter and Control	FETM	. . .	Y26-3693
IBM 1512 Image Projector	FETO	. . .	Y26-4122

FEMM = Field Engineering Maintenance Manual
IPC = Illustrated Parts Catalog
FEMDM = Field Engineering Maintenance Diagrams Manual
FETM = Field Engineering Theory - Maintenance Manual
FETO = Field Engineering Theory of Operation
SRL = Systems Reference Library

APPENDIX B

Audiometer Trainer Unit
Instructional Manual

Audiometer Trainer Unit

Instructional Manual

Developed pursuant to subcontract
OEG-TPSU-4586-01
with
The Pennsylvania State University
under a grant from the
U. S. Office of Education
Department of Health, Education, and Welfare

August 1968

Federal Systems Division
INTERNATIONAL BUSINESS MACHINES CORPORATION
Gaithersburg, Maryland

FOREWORD

This publication describes the Audiometer Trainer Unit (ATU) and its operation. Also included is information on authoring in Coursewriter for ATU use with both the 1500 IS and the 1050 System.

The physical planning considerations necessary for operation of the ATU are covered herein.

A list of IBM publications with which the user of the ATU should be familiar is also included.

CONTENTS

Page

INTRODUCTION 1

DESCRIPTION 1

CONFIGURATIONS 3

CONTROL PANEL 3

ATU OPERATION 3

PHYSICAL PLANNING 11

  Dimensions 11

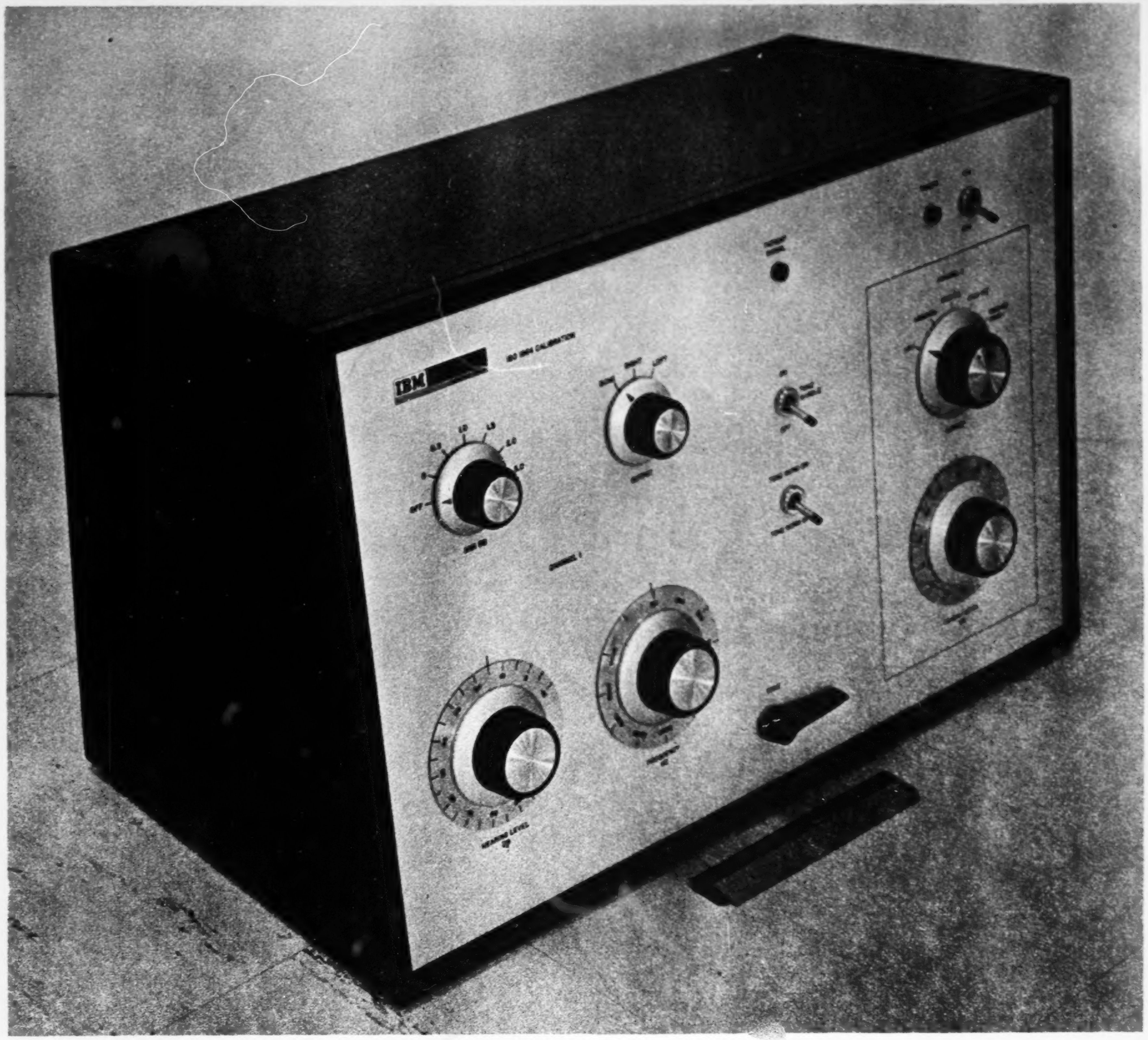
  1500 Connection 11

  1050 Connection 11

APPENDIX 14

  Listing of the Function Required to Change Input Devices in the 1500 System (Function CH)

BIBLIOGRAPHY 17


IBM
ISO 1964 CALIBRATION
LEFT
OFF
1.0
1.5
2.0
HEARING LEVEL

Audiometer Trainer Unit

INTRODUCTION

The IBM Audiometer Trainer Unit (ATU) is a unique device which applies Computer Assisted Instruction (CAI) to laboratory exercises or "hands-on" training in Audiology. For this training, the student must perform practical exercises on an audiometer, a device used to test a patient's hearing.

In learning to operate and perform hearing examinations with the audiometer, subjects must be available to act as patients. In audiology classes these "patients" are other students of the class whose hearing is usually normal.

The ATU, operated in conjunction with a CAI program in Coursewriter language, provides step-by-step instruction in the operation of audiometers without the necessity for an instructor's continual checking or testing of performance. The CAI program is written to simulate the "patient" under examination; therefore, the student may be presented with hearing characteristics representing any abnormalities desired. Even audiometer malfunction can be simulated.

DESCRIPTION

Audiometers are built by several manufacturers; the design depends on whether the device is for use in schools as a screening device, for use in clinics and hospitals, or for use in more specialized examinations. Outwardly, the ATU is representative of audiometers in general use (Figure 1). It has dials, switches, etc., similar to those on standard American pure-tone audiometers. Dial labeling, knob size, etc., represent the generally accepted practice in the field.

Transition from the ATU to an actual audiometer should be no more difficult for the student than the transition from the audiometer of one manufacturer to that of another.

Internally, the ATU contains none of the tone-generating and control functions found in actual audiometers. It contains instrumentation for encoding the switch positions as well as controls and interface circuitry to supply the computer with these positions.

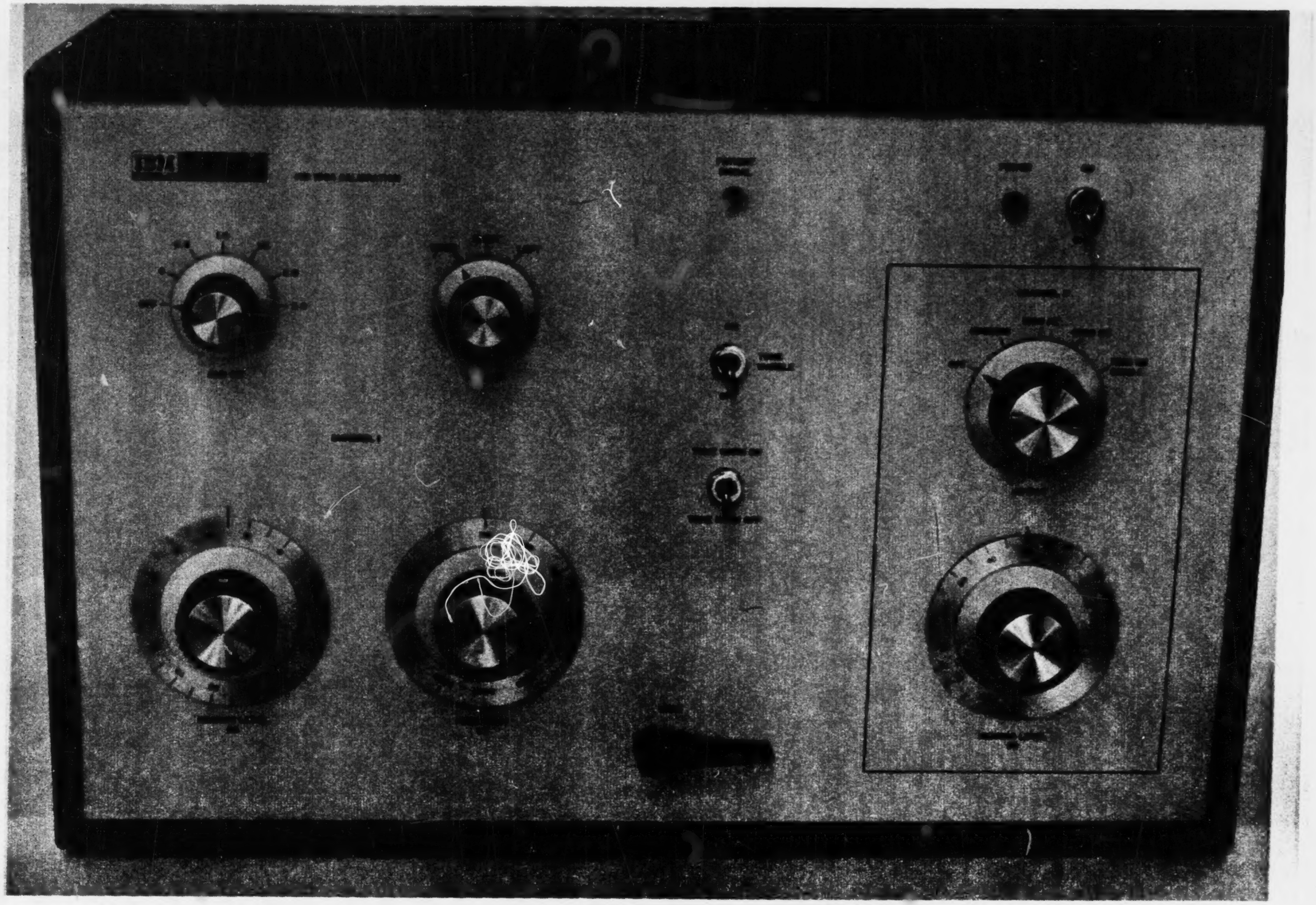


Figure 1. Audiometer Trainer Unit, Front Panel

CONFIGURATIONS

The ATU is designed to operate with either an IBM 1050 Terminal or the IBM 1500 Instructional System. Although the external appearance and purpose of the unit is the same, the ATU contains different subchassis, different connectors, and has a different operating sequence for each configuration.

CONTROL PANEL

The control panel of the ATU contains dials and switches which are found on standard audiometers. Figure 2 lists the functions of all dials, switches, and lights.

ATU OPERATION

When the ATU is attached to either the IBM 1500 Instructional System or the IBM 1050 Terminal, the author of a Coursewriter language program can request input from the ATU with standard Coursewriter instructions transmitted via standard output devices (printer, display, etc.). When a student receives such a request, he sets the ATU front panel dials and switches as instructed and presses the TONE lever. Coded switch positions are then transferred to the IBM 1050 Terminal or the 1500 Instructional System under control of the Coursewriter program. Figure 3 shows switch coding for each position of each switch. The following subsections describe steps in the ATU operational sequence which are peculiar to 1500 and 1050 operation.

OPERATION WITH THE IBM 1500 INSTRUCTIONAL SYSTEM

For IBM 1500 IS Operation, the ATU is used at the student station in place of the IBM 1518 typewriter. Input and output to the ATU is handled like input and output for the 1518 typewriter. Since the ATU does not have a keyboard, the IBM 1510 display keyboard at the student station must be used for student sign-on, sign-off, and other required non-ATU input functions.

To accept inputs from the ATU, it is necessary for the author to change the input device from the display keyboard to the ATU and back again. A

DIAL, SWITCH, OR LIGHT	FUNCTION
ON-OFF switch	Controls overall operation of the ATU. A non-operational code is indicated to the computer when this switch is in the OFF position.
POWER light	Lights when the ON-OFF switch is in the ON position.
PATIENT SIGNAL light	Illuminates on command from the computer to simulate a patient's response when the unit is connected to the 1500 System.
Channel 1	
SISI DB	A 7-position rotary switch equivalent to controls on audiometers for Short Increment Sensitivity Index testing.
BONE - RIGHT - LEFT	A 3-position switch equivalent to Channel 1 output selection on standard audiometers - encodes for the right ear, the left ear, or bone positions.
HEARING LEVEL	A 25-position rotary switch equivalent to the attenuation dial on standard audiometers. Labeling is from -10 to 110 db in increments of 10 with indexing every 5 db.
FREQUENCY	A 12-position rotary switch which has 11 descrete frequency positions plus a blank position which is labeled "speech" on some audiometers.
TONE WARBLE	Corresponds to the switch on an audiometer which causes the tone from Channel 1 to be varied when the switch is in the ON position.

Figure 2. Switch, Dial, and Light Functions (Sheet 1 of 2)

DIAL, SWITCH, OR LIGHT	FUNCTION
TONE NORM ON-OFF	Corresponds to the audiometer switch which determines whether the tone from Channel 1 is normally on or off. When this switch is in the ON position, the TONE switch turns the tone off. When it is in the OFF position, the TONE switch turns the tone on.

Channel 2

Note: On a standard audiometer, Channel 2 refers to the ear not specified by the Channel 1 OUTPUT switch, when the switch is set to RIGHT or LEFT. There is no output from Channel 2 when the switch is set to BONE. For the ATU, each control position is encoded independent of the position of any of the other controls.

OUTPUT	A 5-position rotary switch which indicates whether the Channel 2 output from an audiometer is OFF, MASKING, 1000 Hz, 4000 Hz, or whether 100 Hz is being supplied to Channel 1.
HEARING LEVEL	A 21-position rotary switch which has the same function as the Channel 1 HEARING LEVEL switch, except that labeling is from 0 to 100 db.

Figure 2. (Sheet 2 of 2)

CHARACTER / SWITCH	ALPHAMERIC CHARACTER																									1050 CODE							1500 CODE					
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	1	2	4	8	A	B	C	1	2	4	8	A	B
CS1 HEARING LEVEL (CH.2)																																						
(DB) 0	X																										X		X			X	X	X		X		
5		X																								X							X	X	X	X	X	X
10			X																								X						X	X	X		X	
15				X																						X	X					X						
20					X																							X					X	X		X		X
25						X																				X		X				X	X	X	X	X		
30							X																															
35								X																		X	X	X					X	X	X	X		X
40									X																				X				X	X	X			X
45										X																X			X				X	X				
50											X															X				X	X			X	X			X
55												X															X			X	X		X					
60													X													X	X			X	X	X						
65														X													X			X	X		X		X	X		X
70															X											X	X			X	X	X	X		X	X		
75																X											X	X		X	X	X			X		X	X
80																	X									X	X	X		X	X				X	X	X	X
85																		X											X	X	X		X			X		
90																			X							X			X	X	X	X		X	X			
95																				X						X					X	X			X	X	X	
100																					X						X				XX				X			
CS2 TONE WARBLE																																						
ON	X																										X	X				X	X	X		X		
OFF		X																								X							X	X	X	X	X	X
CS3 TONE																																						
NORM ON	X																										X	X				X	X	X		X		
NORM OFF		X																								X							X	X	X	X	X	X
CS4 SISI																																						
(DB) OFF	X																										X		X			X	X	X		X		
0		X																								X							X	X	X	X	X	X
0.5			X																								X						X	X	X		X	
1.0				X																						X	X					X	X	X	X		X	X
1.5					X																							X					X	X		X		X
2.0						X																				X		X				X	X	X	X	X		
5.0							X																				X	X				X	X	X	X			
CS5 OUTPUT																																						
RIGHT		X																								X							X	X	X		X	
LEFT			X																								X						X	X	X	X	X	X
BONE	X																										X		X			X	X	X		X		
CS6 OUTPUT (CH.2)																																						
OFF	X																										X		X			X	X	X		X		
MASKING		X																								X							X	X	X	X	X	X
1000 HZ			X																								X						X	X	X		X	
4000 HZ				X																						X	X					X	X	X	X		X	X
(CH.1) 1000 HZ					X																							X					X	X		X		X

Figure 3. ATU Switch Coding (Sheet 1 of 2)

CHARACTER		ALPHAMERIC CHARACTER																									1050 CODE							1500 CODE					
SWITCH		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	1	2	4	8	A	B	C	1	2	4	8	A	B
C57 HEARING LEVEL (DB)	-10	X																										X		X			X	X	X		X		
	-05		X																								X							X	X	X	X	X	X
	0			X																								X						X	X	X		X	
	5				X																						X	X					X	X	X	X		X	X
	10					X																							X					X	X		X		X
	15						X																				X		X				X	X	X	X	X		
	20							X																				X	X				X	X	X	X			
	25								X																		X	X	X					X	X	X	X		X
	30									X																				X				X	X	X			X
	35										X																X			X			X	X	X				
	40											X															X				X	X			X	X			X
	45												X															X			X	X		X					
	50													X													X	X			X	X	X	X		X			X
	55														X														X		X	X		X		X	X		X
	60															X											X		X		X	X	X	X		X	X		
	65																X											X	X		X	X	X			X		X	X
	70																	X									X	X	X		X	X				X	X	X	X
	75																		X											X	X	X		X			X		
	80																			X							X			X	X	X	X		X	X			
	85																				X						X					X	X			X	X	X	
	90																					X						X				X	X	X		X			
	95																						X				X	X				X		X			X		X
	100																							X					X			X	X		X	X	X	X	X
	105																								X		X		X			X		X		X		X	
	110																									X		X	X			X			X		X		X
C58 FREQUENCY (H2)	BLANK	X																										X		X			X	X	X		X		
	125		X																								X							X	X	X	X	X	X
	250			X																								X						X	X	X		X	
	500				X																						X	X					X	X	X	X		X	X
	750					X																							X					X	X		X		X
	1000						X																				X	X					X	X	X	X	X		
	1500							X																				X	X				X	X	X	X			
	2000								X																		X	X	X					X	X	X	X		X
	3000									X																				X				X	X	X			X
	4000										X																X			X			X	X	X				
	6000											X															X				X	X			X	X			X
	8000												X															X			X	X		X					

Figure 3. (Sheet 2 of 2)

function (example in Appendix A) may be used to accomplish this. This particular function is coded:

$$\text{fn ch}\overset{(a)}{/}\text{(k)}$$

where:

a changes the response device to the ATU (typewriter)

k changes the response device to the display keyboard.

Any other specification is an error, and the student is automatically signed off.

The input of the ATU code over the interface to the IBM 1502 is treated as an input from the typewriter keyboard. Coursewriter language may be used without any programming restrictions. For example, to request an ATU response, the author would code:

ep ˙ /˙ ˙ /˙ ˙ /˙ tttt ˙ /˙ kk ˙ /˙ i, . . . i_{10} ˙ /˙ ⓔ

where:

tttt is author time-out in tenths of seconds.

kk is the length of the character code to be accepted.
(must be less than or equal to 8)

i, . . . i_{10} is response identifier (10 characters or less).

> Note 1: The sixth alternate coded slash is necessary whenever a response is requested from the ATU.
>
> Note 2: If the ATU power is not on when the response request (ep) instruction is executed, the student will be signed off.

The sequence of steps in using the ATU with the 1500 system is:

1. ATU power is turned on.
2. The student input device is changed from 1510 display keyboard to ATU (substituting for 1518 typewriter).
3. Response is requested from the ATU (ep instruction).
4. The ATU switches are set and the TONE lever is pressed.
5. A character code (Figure 3) allowed by an ⓔ is received in the input buffer (b0) and handled by the program exactly as if it had been received from the typewriter. (The character code length was specified in the ep instruction.)

6. The TONE lever is released and the characters are received again. This permits determination of how long the lever was held down.

7. Successive responses from the ATU may be obtained by waiting for a response to be requested and then depressing the TONE lever.

8. Depressing the TONE lever before the response is requested will cause incorrect input to the computer. The student should be told to operate the TONE lever only when he is instructed to do so.

9. To turn on the ATU PATIENT SIGNAL light, code:

   ty b /̈ ⓔ

   The alternate-coded slash character is required.

10. To Turn off PATIENT SIGNAL, code:

   ty w /̈ ⓔ

Operation with the IBM 1050 System

Exact coding depends on the instructional system used. In general, input from the ATU is handled exactly as input from the 1050 typewriter keyboard.

1. ATU power is turned on.
2. Response is requested from the keyboard or ATU (the station is polled).
3. ATU switches are set and TONE lever pressed. Reader start is pressed on the 1050 (Request is not necessary).
4. An eight-character code followed by an EOB is received in the input buffer and is handled by the program exactly as if it had been received from the 1050 typewriter.
5. Text may normally be outputted to the 1050 typewriter. The patient hearing on the ATU may not be used.
6. Successive responses from the ATU may be obtained by waiting for the station to be polled and then depressing the TONE lever.
7. Depressing the TONE lever before the station has been polled will cause incorrect input to the computer. The student should be told to operate the TONE lever only when he is instructed to do so.

Example:

1500 IS

```
pr ⓔ
        .. .. ..
dt 6, 3 / / / Set the . . .
      ..
fn ch / a ⓔ
   .. .. .. .. ..    ..
ep / / / / 8 / pr 78 / ⓔ

nx ⓔ
    ..
de 0/ 32 ⓔ
         .. .. ..
dt  6, 3 / / / You must not
      understand . . . . . . .

pae ⓔ

br ⓔ ⓔ

ca (c1c2c3c4c5c6c7c8) ⓔ
        ..
ty  b  / ⓔ

de 0/ 32 ⓔ
        .. .. ..
dt 6, 3 / / /  The patient heard . . .

pae ⓔ
      ..
ty  w / ⓔ

wa (--------) ⓔ

de  9/32 ⓔ
             .. .. ..
dt    6,3, / / /   The patient did not hear . . .
.
.
.
pr
       ..
de  0 / 32

dt  6, 3 / / / Now use the display
                      keyboard . . . .
        ..
fn  ch / k ⓔ
.
.
.
```

1050 System

```
qu Set the . . .

ca c1c2c3c4c5c6c7c8

ty The patient heard . . .



wa (--------)

ty  The patient did not hear . . .

u
un  You must not understand . . .
```

PHYSICAL PLANNING

Dimensions

The overall dimensions of the ATU are 21-3/4" wide by 14" high by 11-3/4" deep, including control knobs.

1500 Connection

For use with the 1500 System, the ATU must contain the 1500 sub-chassis (shown installed in Figure 4). The ATU is connected to the 1502 student station through a 12-foot cable. A station B connector is required. Power to the ATU is supplied through a separate 110-volt, 60-cycle power cord.

1050 Connection

For 1050 operation, a reader position feature is required on the 1050 terminal, and the ATU must contain the 1050 sub-chassis (Figure 5). ATU power as well as 1050/ATU interface connections are supplied by a single cable.

Installation Clearance

8" is required at the rear of the ATU cabinet for cable connector anc cable bend radius. A 4" projection of desk in front of ATU is desirable for operator to rest hand.

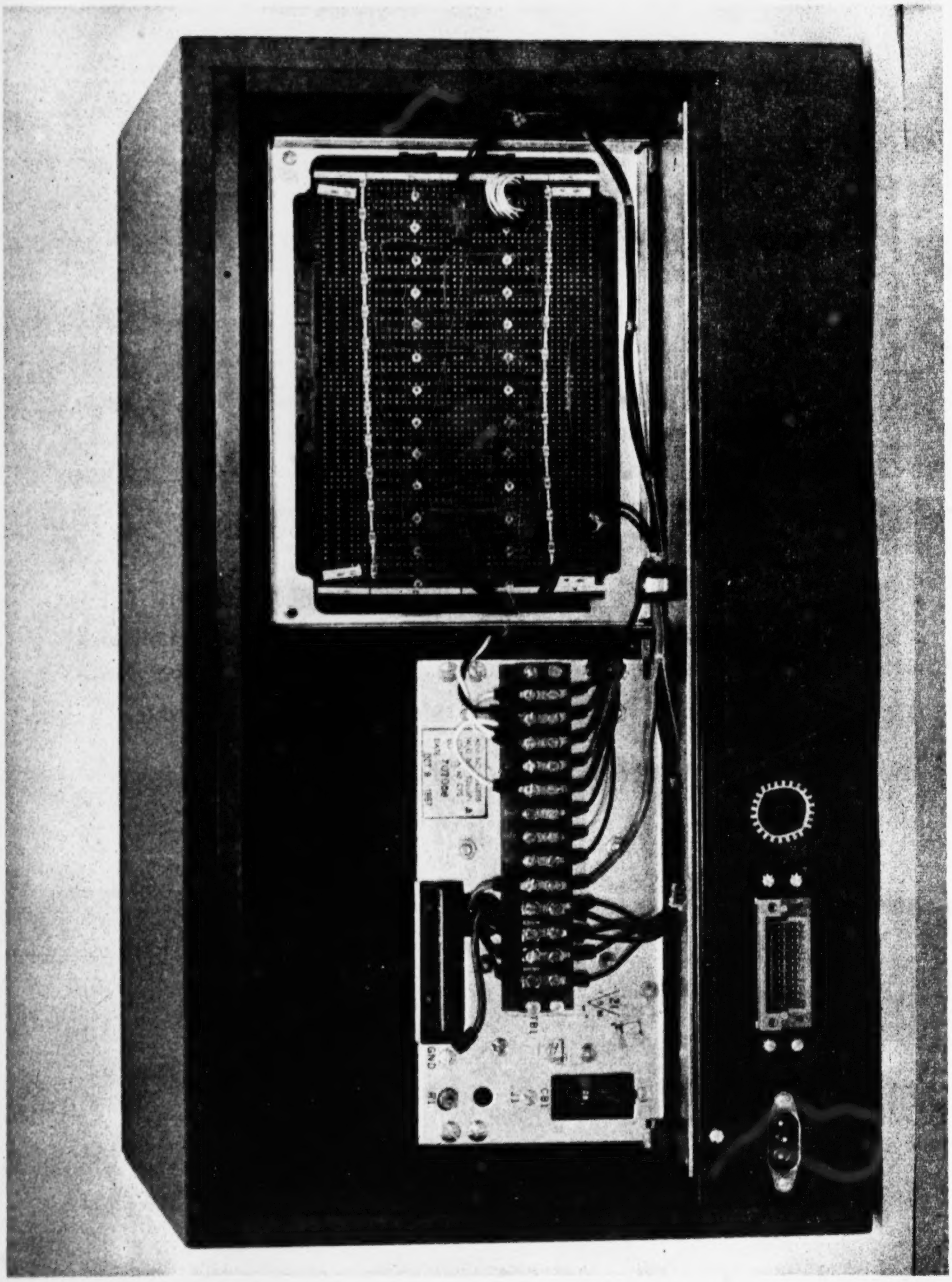


Figure 4. 1500 Subchassis (Shown Installed)

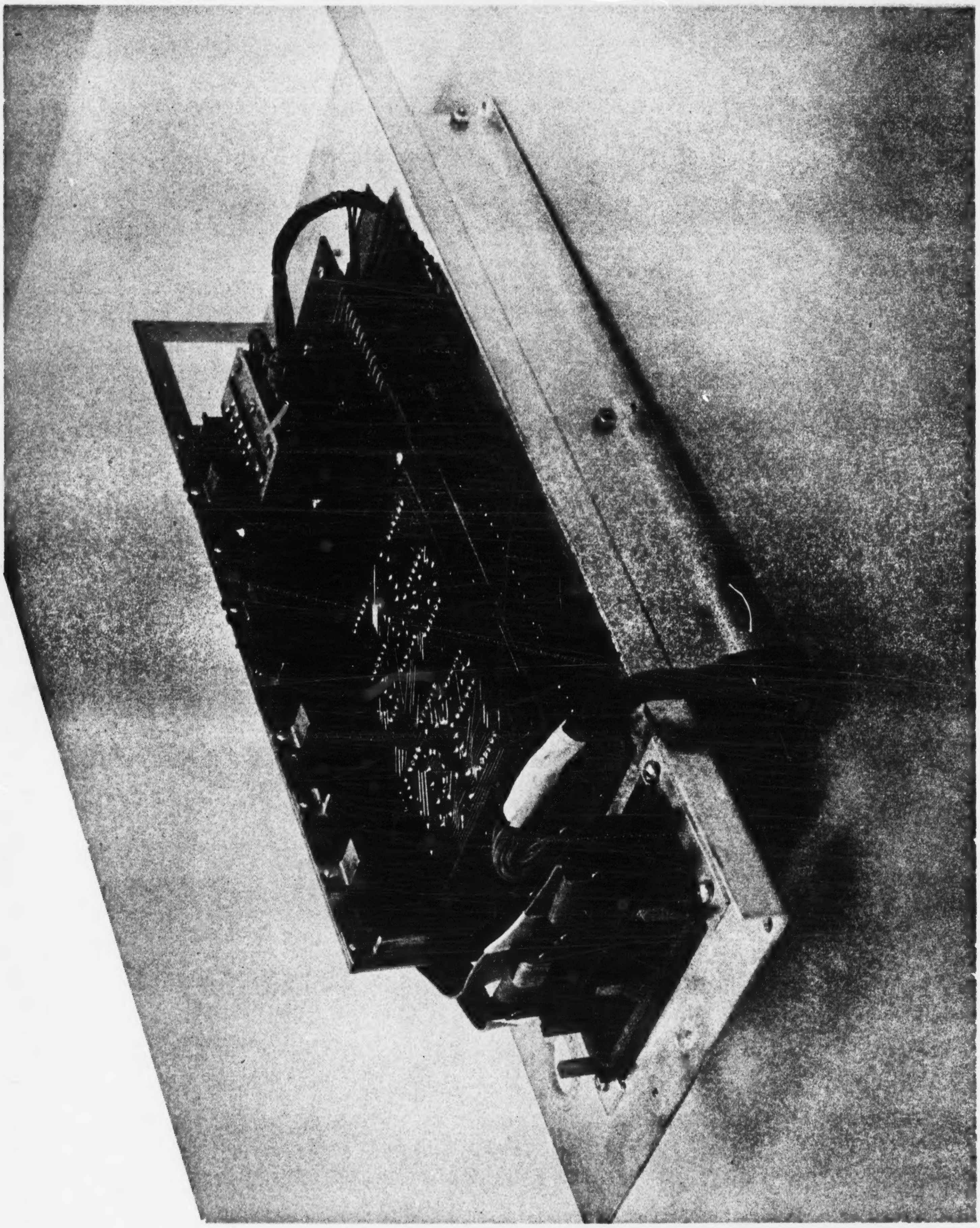


Figure 5. 1050 Subchassis

APPENDIX

Listing of the Function Required To Change Input Devices in the 1500 System

(Function CH)

```
                         *
                         *     CH FUNCTION
                         *
                         *     THIS FUNCTION ALLOWS THE INPUT DEVICE TO
                         *     BE CHANGED FROM KEYBOARD TO AUDIOMETER OR
                         *     FROM AUDIOMETER TO KEYBOARD
                         *     THE CALL SEQUENCE IS  FN  CH/L@
                         *     / IS AN ALTERNATE CODED SLASH
                         *     L IS A LETTER, EITHER K  CHANGE TO KEYBOARD
                         *     OR A CHANGE TO AUDIOMETER
                         *     @ IS AN EOB
                         *     ANY OTHER CALL SEQUENCE IS ILLEGAL
                         *     AN ILLEGAL CALL SEQUENCE CAUSES AN
                         *     INTERPRETER ERROR EXIT WITH ERROR CODE 51
                         *
1D7C                     ATR   EQU     /1D7C     TERMINAL RECORD BASE
1D8B                     ATRE3 EQU     ATR&15    TYPE INPUT DEVICE
                         *                       1  1510
                         *                       2  1518 OR AUDIOMETER
1EEE                     ATRE6 EQU     ATR&370   PTR TO FUNCTION PARAMETERS
1EF0                     ATRE8 EQU     ATR&372   FUNCTION SWITCH
1EF2                     ATRFR EQU     ATR&374   FUNCTION RETURN TO INTERP
2282                     CERIN EQU     /2282     ERROR RETURN TO INTERP
                         *
                         *
0000 00 C4801EEE         CH000 LD   I  ATRE6
0002 0  F012                   EDR     CH001
0003 01 4C18000E               BSC  L  CH002,&-  BRANCH IF CHANGE TO K3D
0005 0  F010                   EOR     CH003
0006 01 4C180013               BSC  L  CH004,&-  BR OF CHANGE TO AUDIOMTR
0008 0  1010                   SLA     16
0009 00 D4001EF0               STO  L  ATRE8     RESET FUNCTION SWITCH
000B 0  C00B                   LD      CH005     LOAD ERROR CODE
000C 00 4C802282               BSC  I  CERIN     GO TO INTERP ERROR EXIT
000E 0  C009             CH002 LD      CH006     LOAD KEYBOARD CONSTANT
000F 00 D4001D8B         CH008 STO  L  ATRE3     STORE IN TRA
0011 00 4C801EF2               BSC  I  ATRFR     EXIT
0013 0  C005             CH004 LD      CH007     LOAD TYPEWRITER CONSTANT
0014 0  70FA                   MDX     CH008
0015 0  9226             CH001 DC      /9226     K,EOB
0016 0  1300             CH003 DC      /1300      K,EOB  EOR  A,EOB
0017 0  F5F1             CH005 DC      /F5F1     ERROR CODE 51
0018 0  0001             CH006 DC      /0001     1510
0019 0  0002             CH007 DC      /0002     1518 OR AUDIOMETER
001A    0000                   END     CH000
 NO ERRORS
```

```
CROSS REFERENCE INFORMATION

SYMBOL  VALUE      REFERENCES

ATR     1D7C       0000,0000,0000,0000,0000,0000,0000,0000
ATRE3   1D8B       000F
ATRE6   1EEE       0000
ATRE8   1EF0       0009
ATRFR   1EF2       0011
CERIN   2282       000C
CH000   0000       001A
CH001   0015       0002
CH002   000E       0003
CH003   0016       0005
CH004   0013       0006
CH005   0017       000B
CH006   0018       000E
CH007   0019       0013
CH008   000F       0014
```

BIBLIOGRAPHY

1. IBM 1500 Operating System, Computer-Assisted Instruction, Coursewriter II (CAI-4036)
2. IBM 1500 Instructional System, System Summary (CAI-4038)
3. IBM 1500 Instructional System, System Configurator (CAI-4041)
4. IBM 1130 Computing System Principles of Operation (A26-5881)
5. IBM 1500 Instructional System, Introduction to Computer-Assisted Instruction and System Summary (Y26-5610) (Restricted Distribution)
6. IBM 1500 Coursewriter II Author's Guide, Part I: Course Planning (Y26-5570) (Restricted Distribution)
7. IBM 1500 Coursewriter II Author's Guide, Part II: Course Program Development (Y26-5681) (Restricted Distribution)
8. IBM 1500 Instructional System, Computer-Assisted Instruction, Student's Guide (Y26-5796) (Restricted Distribution)
9. IBM 1500 Instructional System, User's Guide, Station Commands (Y26-5788) (Restricted Distribution)
10. Coursewriter III for System/360, Application Description (Z20-1872) (IBM Confidential)
11. Coursewriter III for System/360 (360A-UX-01L) Student/Monitor User's Guide (Z20-1875) (IBM Confidential)
12. Coursewriter III for System/360 (360A-UX-01L) Author's Guide (Z20-1876) (IBM Confidential)
13. Coursewriter III for System/360 (360A-UX-01L) Supervisor's Guide (Z20-1877) (IBM Confidential)
14. Coursewriter III for System/360 (360A-UX-01L) System Programmer's Guide (Z20-1878) (IBM Confidential)

BIBLIOGRAPHY (Concluded)

15. Coursewriter III System Student/Monitor Reference Card (Z20-1879) (IBM Confidential)

16. Procedures for Transmitting/Receiving Messages between an IBM Data Processing System and a 1050 Data Communication System (C20-1664)

17. IBM 1050 Operator's Guide (A24-3125)

APPENDIX C

Written Course Frames

Appendix C

Example of a "Dry Run" Program

2\.

dt: The device you will work with most is the Pure Tone Audiometer simulator which you see to your right. It is similar to commercial Pure Tone Audiometers but it is connected to the computer. In this computer-assisted course you will learn its basic operation and will use it to practice giving hearing tests. The first thing you'll get is a basic introduction to the use of the audiometer panel.

If you have used an audiometer before, you can skip the introduction (if you can pass a test)

If you have never used an audiometer before - press the light pen here.
If you have used one to some extent and want to skip ahead, - press the light pen here:

ep:

---

ca: (none) - #3
aa: (used) - Branch Br 1
un: Message C [light pen error - try again.]

3.

dt: 1. POWER SWITCH

Look at the audiometer panel. As you might expect, the first thing to do to the machine is to turn it on. The power switch is located in the upper right-hand corner of the panel. Turn it on now, then do the following:

If the light next to the power switch came on, press the light pen here:
If the light did not come on, press the light pen here:

---

ca: Light on - #6
wa: Light not on - #4
un: Light pen in undefined areas - Message C

4.

dt: You indicated that the light did not come on.
The light may not be working properly, or you may have the wrong switch. The light is just under the word POWER in the upper right-hand corner, and the switch is just to the right of it.

Flip the power switch up.
If the light still does not come on - press the light pen here:
If the light does come on - press the light pen here:

ep:

---

wa: Light still off - #15
ca: Light on - #6
un: Response not in allowable area - Message C

5.

dt: Apparently you are still having a problem. The switch you should be working with is highlighted on the display screen. Try it again.

If it works this time, press the light pen here:
If it still does not work, press the light pen here:

Slide of the audiometer panel. Highlight "on" switch.

---

ca: YES - #6
wa: NO - proctor message (machine malfunction)
un: Message B

6.

2. TONE NORM ON/OFF SWITCH

dt: The TONE NORM ON/OFF switch (near the center of the panel) determines whether a tone in the earphone is normally on, or normally off. If you wanted the tone to be normally on, you would set the switch to TONE NORM ON. To have the tone normally off, you would set the switch at TONE NORM ____________________[type the answer.]

ep

---

ca: OFF - #7
wa: ON - #6a
un: Message B

6a

dt: You said that you would set the switch at TONE NORM ON. This would be correct if you wanted the tone to be usually on, but to have the tone normally off, you would have to set the switch at TONE NORM____________________.

ep:

---

ca: OFF - #7

un: #6b

6b

dti The tone is normally off when the switch is set to TONE NORM OFF

dt: #7

7.

dti: Right

3. TONE SWITCH

dt: When you are giving hearing tests, you will usually have the tone normally OFF (tone normally ON has special uses.) You will present the tone to the patient by pressing down the TONE switch, located in the lower center of the panel. In other words, when the TONE NORM ON/OFF switch is set to TONE NORM OFF, you can turn the tone on by pressing the ____________________________switch.

ep:

---

ca: TONE - #8 with dti$_1$ 8
aa: INTERRUPTER - 7a
ab: T* - 7b
un: 7c

APPENDIX D

Computer Listings of Representative Portions of the Audiometry Course

```
**LSTCSE
**AUDIO 000 FR1                FR7A          30 00137
FR1*E
$$ 1  NO  (COMMENT& T)HIS IS THE START OF THE INSTRUCTIONAL MATERIAL.  (T)O ALLOW FOR PRIOR EXPERIENCE WITH AUDIOMETERS
          , THE*E
$$ 2  NO  STUDENT IS GIVEN AN OPPORTUNITY TO SKIP THE INTRODUCTORY MATERIAL IF HE CAN PASS A TEST OF KNOWLEDGE CONCERNIN
          G*E
$$ 3  NO  PANEL SETTING.*E
   4  PRR *E
   5  DE  0+/32*E
   6  FPO *E
   7  DT  0,0+/2,0+/40,0+/   (Y)OU WILL WORK MOST WITH THE (P)URE (T)ONE*E
   8  DT  ,0+/2,+/40,0+/(A)UDIOMETER (S)IMULATOR, ON YOUR RIGHT, TO*E
   9  DT  ,0+/2,+/40,0+/PRACTICE GIVING HEARING TESTS.*E
  10  DT  ,0+/2,+/40,0+/+/*E
  11  DT  ,0+/2,+/40,0+/   (F)IRST IS AN INTRODUCTION TO AN*E
  12  DT  ,0+/2,+/40,0+/AUDIOMETER PANEL.*E
  13  DT  ,0+/2,+/40,0+/+/*E
  14  DT  ,0+/2,+/40,0+/   (I)F YOU KNOW HOW TO USE AN AUDIOMETER*E
  15  DT  ,0+/2,+/40,0+/AND WANT TO SKIP AHEAD (9)IF YOU CAN PASS*E
  16  DT  ,0+/2,+/40,0+/A TEST(0 )- (PRESS LIGHT PEN HERE )- - +0*BO+0*BO*E
  17  DT  ,0+/2,+/40,0+/+/*E
  18  DT  ,0+/2,+/40,0+/   (I)F YOU WANT TO TAKE THE COMPLETE*E
  19  DT  ,0+/2,+/40,0+/COURSE -  (PRESS HERE )- - - - - - - +0*BO+0*BO*E
  20  DT  ,0+/2,+/40,0+/+/*E
  21  EPP 400+/FR1*E
  22  NX  *E
  23  BR  LONG*E
  24  CAP 4,17,4,35+/F1*E
  25  BR  PRETST*E
  26  CAP 4,23,4,35+/F1*E
  27  BR  FR2*E
  28  UN  F1*E
  29  DE  27+/5*E
  30  DT  27,0+/4,27+/40,0+/   (Y)OU PRESSED THE LIGHT PEN ON THE*C*IWRONG SPOT.  (P)RESS IT ON THE SQUARES.*E
  31  EA  *E
PRETST*E
   1  PRR *E
   2  LD  0+/S2*E
   3  DE  0+/32*E
PRE1*E
$$ 1  NO  (COMMENT& T)HIS IS THE START OF THE PRETEST.  (P)RETEST CODING CONTINUES TO THE LABEL ('FR)2(').*E
   2  DT  0,16+/2,0+/40,0+/(PRETEST*E
   3  DT  ,0+/2,+/40,0+/+/*E
   4  DT  ,0+/2,+/40,0+/  (S)ET THE (A)UDIOMETER (S)IMULATOR AS IF YOU*E
   5  DT  ,0+/2,+/40,0+/WERE TESTING A PATIENT'S LEFT EAR WITH*E
   6  DT  ,0+/2,+/40,0+/4000 (HZ )AT 40 (DB).*E
   7  DT  ,0+/3,+/40,0+/*I  (T)URN ON THE (A)UDIOMETER (T)RAINER FIRST.*E
   8  DT  ,0+/2,+/40,0+/(Y)OU CAN TELL IT IS ON WHEN THE LIGHT IS*E
   9  DT  ,0+/2,+/40,0+/ON.  (P)RESS THE (SPACE BAR )WHEN IT'S ON.*E
  10  EPI ,39+/2,+/1,37+/600+/1+/*E
  11  NX  *E
  12  DT  24,0+/6,24+/40,0+/  (I)T LOOKS LIKE YOU'RE HAVING SOME*C*ITROUBLE TURNING IT ON.  (P)ERHAPS SOME*C*IREVIEW WOU
          LD BE HELPFUL.*E
  13  LR  FR2+/RR1*E
  14  BR  PGTRN*E
  15  AA  (8+/)ZZ*E
  16  DL  18,0+/40*E
  17  DT  19,0+/1,19+/40,0+/*E
  18  DT  ,0+/2,+/40,0+/  (N)OW USE THE TONE SWITCH TO GIVE A*E
  19  DT  ,0+/2,+/40,0+/TONE OF NORMAL DURATION.  (I)T WORKS JUST*E
  20  DT  ,0+/2,+/40,0+/LIKE ALL TONE SWITCHES OR BARS.*E
```

```
 21  FN   CH+/A*E
 22  FN   SF+/3+/C20*E
 23  EP   ,0+/2,+/40,0+/500+/8+/PRETEST+/*E
 24  LD   C0+/C21*E
 25  LD   B0+/B1*E
 26  NX   *E
 27  DL   22,0+/40*E
 28  DT   23,0+/2,23+/40,0+/  (Y)OU HAVE TAKEN A LITTLE TOO LONG WITH*E
 29  DT   ,0+/6,+/40,0+/THIS PROBLEM.  (S)OME REVIEW WOULD*C*IPROBABLY BE HELPFUL.*E
 30  LR   FR2+/RR1*E
 31  BR   PGTRN*E
 32  AA   (8+/)AA*E
 33  FN   SF+/3+/C23*E
 34  EP   ,0+/2,+/40,0+/200+/8+/PRETEST+/*E
 35  NX   *E
 36  BR   FR2+/S2+/1*E
 37  LD   1+/S2*E
 38  DL   22,0+/40*E
 39  DT   23,0+/6,23+/40,0+/  (Y)OU DID NOT PRESS THE TONE SWITCH LONG*C*IENOUGH OR YOU HELD IT DOWN TOO LONG.*C*I(T)RY
          IT AGAIN ONE MORE TIME.*E
 40  BR   PRE1*E
 41  AA   (8+/)ZZ*E
 42  LD   C0+/C22*E
 43  LD   C23+/C24*E
 44  SB   C20+/C24*E
 45  AD   C22+/C24*E
 46  SB   C21+/C24*E
 47  FN   DCOUNT+/C24+/B4+/5*E
 48  FN   MV+/'.'+/B4,3+/IA*E
 49  LD   B1+/B0*E
 50  CA   1A92(8)010+/CA*E
 51  BR   PREC1+/C24+/G+/40*E
 52  BR   PREC1+/C24+/L+/20*E
 53  BR   PREC*E
 54  AA   1A92(8+/)W1*E
 55  BR   PREW1A+/C24+/G+/40*E
 56  BR   PREW1A+/C24+/L+/20*E
 57  BR   PREW1*E
 58  AA   (8)A92(8+/)W2*E
 59  BR   PREW2A+/C24+/G+/40*E
 60  BR   PREW2A+/C24+/L+/20*E
 61  BR   PREW2*E
 62  UN   UU*E
 63  DE   0+/32*E
 64  FN   CH+/K*E
 65  DT   0,0+/2,0+/40,0+/  (I)'M AFRAID THAT YOU MADE ONE OR MORE*E
 66  DT   ,0+/2,+/40,0+/ERRORS IN CRITICAL PANEL SETTINGS.*E
 67  DT   ,0+/2,+/40,0+/+/*E
 68  DT   ,0+/2,+/40,0+/  (I)T WOULD BE A GOOD IDEA FOR YOU TO*E
 69  DT   ,0+/2,+/40,0+/HAVE A REVIEW OF THE OPERATION OF THIS*E
 70  DT   ,0+/2,+/40,0+/AUDIOMETER.*E
 71  DT   30,0+/2,30+/40,0+/(PRESS THE SPACE*B*B*B*B*B----- BAR*B*B*B--- TO GO ON).*E
 72  EPI  30,39+/2,30+/1,37+/+/1+/*E
 73  AA   (8+/)AA*E
 74  BR   FR2*E
PREC*E
  1  DE   0+/32*E
  2  DT   0,0+/2,0+/40,0+/                      +R+I+G+H+T*E
  3  DT   ,0+/2,+/40,0+/+/*E
  4  DT   ,0+/2,+/40,0+/  (Y)OUR SETTINGS AND DURATION OF TONE*E
  5  DT   ,0+/2,+/40,0+/CORRECT.  (T)HERE IS NO NEED FOR YOU TO*E
  6  DT   ,0+/2,+/40,0+/GO THROUGH THE INTRODUCTION UNLESS YOU*E
```

POOR ORIGINAL COPY - BEST
AVAILABLE AT TIME FILMED

```
    7  DT   ,0+/2,+/40,0+/WANT TO.*E
PRECA*E
    1  DT   12,0+/2,12+/40,0+/+/*E
    2  DT   ,0+/2,+/40,0+/  (I)F YOU WANT A BRIEF REVIEW OF (SISI),*E
    3  DT   ,0+/2,+/40,0+/(TONE WARBLE), AND (CHANNEL )2,*E
    4  DT   ,0+/2,+/40,0+/PRESS THE LIGHT PEN HERE - +O*BO*E
    5  DT   ,0+/1,+/40,0+/+/*E
    6  DT   ,0+/2,+/40,0+/  (T)O GO THROUGHT THE INTRODUCTION TO ALL*E
    7  DT   ,0+/2,+/40,0+/ELEMENTS OF THE PANEL, PRESS HERE - +O*BO*E
    8  DT   ,0+/1,+/40,0+/+/*E
    9  DT   ,0+/2,+/40,0+/  (I)F YOU WANT TO SKIP TO THRESHOLD*E
   10  DT   ,0+/2,+/40,0+/FINDING, PRESS HERE - +O*BO*E
   11  EPP  +/*E
   12  CAP  4,17,3,26+/C1*E
   13  BR   FR25*E
   14  CAP  4,23,3,35+/C2*E
   15  BR   FR2*E
   16  CAP  4,28,3,21+/C3*E
   17  TR   1+/FR1*E
   18  UN   UU*E
   19  DT   0,0+/6,0+/40,0+/*C*I(PRESS THE LIGHT PEN ON A SQUARE).*E
   20  BR   RE*E
PREC1*E
    1  DE   0+/32*E
    2  DT   0,0+/6,0+/40,0+/  (A)LL PANEL SETTINGS WERE CORRECT, BUT*C*ITHE DURATION OF YOUR TONE WAS WRONG.  (I)T*C*IWAS
                 SECONDS, NOT BETWEEN 2 AND 4*E
    3  DT   ,0+/2,+/40,0+/SECONDS, THE ACCEPTABLE DURATION. (P)LEASE*E
    4  DT   ,0+/2,+/40,0+/BE CAREFUL OF THIS AS YOU CONTINUE.*E
    5  DTI  4,4+/2,4+/6,4+/B4*E
    6  BR   PRECA*E
PREW1*E
    1  DE   0+/32*E
    2  DT   0,0+/2,0+/40,0+/  (Y)OUR BASIC (CHANNEL )1 SETTINGS WERE*E
    3  DT   ,0+/2,+/40,0+/CORRECT, (TONE NORM ON)/(OFF )WAS (OFF), AS*E
    4  DT   ,0+/2,+/40,0+/REQUIRED, AND THE TONE DURATION WAS (O).(K).*E
    5  DT   ,0+/2,+/40,0+/+/*E
    6  DT   ,0+/2,+/40,0+/  (H)OWEVER, YOU MADE ERRORS IN OTHER*E
    7  DT   ,0+/2,+/40,0+/SWITCHES (9)EVERYTHING ELSE SHOULD HAVE*E
    8  DT   ,0+/2,+/40,0+/BEEN TURNED OFF(0).*E
PREW1X*E
    1  DT   17,0+/1,17+/40,0+/+/*E
    2  DT   ,0+/2,+/40,0+/  (I)F YOU WANT TO START WITH A BRIEF*E
    3  DT   ,0+/2,+/40,0+/REVIEW OF (SISI), (TONE WARBLE), AND (CHANNEL*E
    4  DT   ,0+/2,+/40,0+/2, PRESS THE LIGHT PEN HERE - +O*BO.*E
    5  DT   ,0+/2,+/40,0+/+/*E
    6  DT   ,0+/4,+/40,0+/  (T)O GO THROUGH THE INTRODUCTION TO ALL*C*IELEMENTS OF THE PANEL, PRESS HERE - +O*BO.*E
    7  EPP  +/PREW1X*E
    8  CAP  4,21,3,30+/C1*E
    9  BR   FR25*E
   10  CAP  4,27,3,36+/C2*E
   11  BR   FR2*E
   12  UN   UU*E
   13  DT   30,0+/2,30+/40,0+/(PRESS THE LIGHT PEN ON A SQUARE).*E
   14  BR   RE*E
PREW1A*E
    1  DE   0+/32*E
    2  DT   0,0+/2,0+/40,0+/  (Y)OUR (CHANNEL )1 PANEL SETTINGS WERE*E
    3  DT   ,0+/2,+/40,0+/CORRECT, AND (TONE NORM ON)/(OFF )WAS*E
    4  DT   ,0+/2,+/40,0+/CORRECTLY SET (OFF), BUT THERE WERE ERRORS*E
    5  DT   ,0+/2,+/40,0+/IN THE OTHER SETTINGS (9)THEY ALL SHOULD*E
    6  DT   ,0+/2,+/40,0+/HAVE BEEN OFF(0), AND YOUR TONE WAS NOT OF*E
    7  DT   ,0+/2,+/40,0+/THE CORRECT DURATION (9)IT WAS FOR*E
   8  DTI 10,34+/2,10+/6,34+/B4*E
   9  DT   ,0+/2,+/40,0+/SECONDS, NOT THE ACCEPTABLE 2 TO 4 SEC.*E
  10  DT   ,0+/2,+/40,0+/(P)LEASE BE CAREFUL OF THIS.(0*E
  11  BR   PREW1X*E
PREW2*E
   1  DE   0+/32*E
   2  DT   0,0+/2,C+/40,C+/  (Y)OUR BASIC (CHANNEL )1 SETTINGS WERE ALL*E
   3  DT   ,0+/2,+/40,0+/RIGHT, AS WAS YOUR TONE DURATION, BUT*E
   4  DT   ,0+/2,+/40,0+/OTHER SWITCHES, INCLUDING (TONE NORM ON)/*E
   5  DT   ,0+/2,+/40,0+/(OFF), WERE NOT TURNED OFF, AS THEY SHOULD*E
   6  DT   ,0+/2,+/40,0+/HAVE BEEN.*E
PREW2X*E
   1  DT   16,0+/2,16+/40,0+/+/*E
   2  DT   ,0+/2,+/40,0+/  (I)F YOU WANT TO START WITH A REVIEW OF*E
   3  DT   ,0+/2,+/40,0+/(TONE NORM ON)/(OFF )AND THE OTHER SPECIAL*E
   4  DT   ,0+/2,+/40,0+/FUNCTIONS, PRESS THE LIGHT PEN HERE - +0*BO.*E
   5  DT   ,0+/2,+/40,0+/+/*E
   6  DT   ,0+/2,+/40,0+/  (T)O GO THROUGH THE INTRODUCTION TO ALL*E
   7  DT   ,0+/2,+/40,0+/ELEMENTS OF THE PANEL, PRESS HERE - +0*BO.*E
   8  EPP +/PREW2X*E
   9  CAP 4,21,3,37+/C1*E
  10  BR   PRETON*E
  11  CAP 4,27,3,35+/C2*E
  12  BR   FR2*E
  13  UN   UU*E
  14  DT   30,0+/2,30+/40,0+/     (PRESS THE LIGHT PEN ON A SQUARE).*E
  15  BR   RE*E
PREW2A*E
   1  DE   0+/32*E
   2  DT   0,0+/2,0+/40,0+/  (Y)OUR (CHANNEL )1 PANEL SETTINGS WERE*E
   3  DT   ,0+/2,+/40,0+/CORRECT, BUT YOU MADE ERRORS IN OTHER*E
   4  DT   ,0+/2,+/40,0+/SETTINGS (9)THEY SHOULD HAVE BEEN OFF(0),*E
   5  DT   ,0+/2,+/40,0+/AND IN THE DURATION OF THE TONE (9)YOU*E
   6  DT   ,0+/2,+/40,0+/PRESSED THE (TONE )SWITCH FOR*E
   7  DT   ,0+/2,+/40,0+/SECONDS& IT SHOULD HAVE BEEN BETWEEN 2*E
   8  DT   ,0+/2,+/40,0+/AND 4 SECONDS(0).*E
   9  DTI 8,28+/2,8+/6,28+/B4*E
  10  BR   PREW2X*E
PRETON*E
   1  PR   *E
   2  DE   0+/32*E
   3  DT   0,0+/2,0+/40,0+/  (T)HE (TONE NORM ON)/(OFF )SWITCH, CIRCLED*E
   4  DT   ,0+/2,+/40,0+/ON THE SLIDE, IS FOUND ON MANY AUDIO-*E
   5  DT   ,0+/2,+/40,0+/METERS.  (I)T DETERMINES WHETHER THE TONE*E
   6  DT   ,0+/2,+/40,0+/IS NORMALLY ON OR OFF IN THE EARPHONES.*E
   7  DT   ,0+/1,+/40,0+/+/*E
   8  DT   ,0+/2,+/40,0+/  (I)N NORMAL USE, THIS SWITCH IS SET TO*E
   9  DT   ,0+/2,+/40,0+/THE (OFF )POSITION (9)TONE NORMALLY OFF(0).*E
  10  DT   ,0+/1,+/40,0+/+/*E
  11  DT   ,0+/2,+/40,0+/  (T)HIS TIME, GIVE THE SUBJECT A TONE OF*E
  12  DT   ,0+/2,+/40,0+/NORMAL DURATION IN THE RIGHT EAR, 30 (DB*E
  13  DT   ,0+/2,+/40,0+/AT 1000 (HZ).*E
  14  DT   ,0+/2,+/40,0+/  (B)E SURE EVERYTHING ELSE IS OFF.*E
  15  LD   0+/S3*E
  16  FN   CH+/A*E
  17  LR   PRETNX+/RR0*E
  18  LR   RESP2+/RR2*E
  19  FN   SF+/3+/C20*E
  20  EP   ,0+/2,+/40,0+/600+/8+/PRETON+/*E
  21  LD   C0+/C21*E
  22  LD   B0+/B1*E
  23  NX   *E
  24  DE  28+/4*E
  25  DT  29,0+/2,29+/40,0+/(I)'M STILL WAITING FOR THE TONE.*E
  26  AA  (8+/)ZZ*E
  27  BR  RESP1*E
PRETNX*E
   1  FN  CH+/K*E
   2  LD  B1+/B0*E
   3  CA  1851(8)010+/CA*E
   4  DE  22+/10*E
   5  BR  PRETNA+/C24+/G+/40*E
   6  BR  PRETNA+/C24+/L+/20*E
   7  DL  25,0+/40*E
   8  DT  26,0+/6,26+/40,0+/  (GOOD).  (COMPLETELY CORRECT).*C*I*I(T)HE NEXT FRAME WILL BE ON IN A MOMENT.*E
   9  LR  FR25+/RR1*E
  10  BR  WAIT1*E
  11  AA  1851(8+/)W1*E
  12  DE  22+/10*E
  13  BR  PRETNB+/C24+/G+/40*E
  14  BR  PRETNB+/C24+/L+/20*E
  15  DL  22,0+/40*E
  16  DT  23,0+/2,23+/40,0+/  (Y)OUR BASIC SETTINGS AND TONE DURATION*E
  17  DT  ,0+/4,+/40,0+/WERE CORRECT, BUT THERE WERE ERRORS IN*C*ITHE SETTINGS OF SWITCHES TO BE DISCUSSED*E
  18  DT  ,0+/2,+/40,0+/IN A FEW MOMENTS.*E
  19  LR  FR25+/RR1*E
  20  BR  WAIT2*E
  21  AA  (8)851(8+/)W2*E
  22  DE  22+/10*E
  23  BR  PRETNC+/C24+/G+/40*E
  24  BR  PRETNC+/C24+/L+/40*E
  25  DL  22,0+/40*E
  26  DT  ,0+/6,+/40,0+/+/*E
  27  DT  23,0+/6,23+/40,0+/  (Y)OUR BASIC SETTINGS AND TONE DURATION*C*IWERE CORRECT, BUT (TONE NORM ON)/(OFF )WAS*C*I(
          ON).  (S)OME FURTHER REVIEW MIGHT BE*E
  28  DT  ,0+/2,+/40,0+/HELPFUL - IT WILL START SHORTLY.*E
  29  LR  FR2+/RR1*E
  30  BR  WAIT2*E
  31  UN  UU*E
  32  DE  22+/10*E
  33  DL  22,0+/40*E
  34  DT  23,0+/6,23+/40,0+/  (Y)OU MADE AN ERROR IN ONE OF THE BASIC*C*ISWITCH SETTINGS.  (F)URTHER REVIEW MIGHT*C*IBE
          HELPFUL - IT WILL START SHORTLY.*E
  35  LR  FR2+/RR1*E
  36  BR  WAIT2*E
PRETNA*E
   1  DL  22,0+/40*E
   2  DT  23,0+/6,23+/40,0+/  (T)HE SETTINGS WERE COMPLETELY CORRECT,*C*IBUT YOUR TONE DURATION WAS NOT, AS YOU*C*ISAW.
           (B)E CAREFUL OF YOUR TONE DURATIONS.*E
   3  DT  ,0+/2,+/40,0+/+/*E
   4  DT  30,5+/2,30+/40,0+/(PRESS THE +S+P+A+C+E +B+A+R CONTINUE).*E
   5  EPI 30,38+/2,30+/1,39+/+/1+/+/*E
   6  AA  (8+/)ZZ*E
   7  BR  FR25*E
PRETNB*E
   1  DL  22,0+/40*E
   2  DT  23,0+/6,23+/40,0+/  (B)ASICALLY CORRECT, BUT YOU MADE ERRORS*C*IIN SETTING SOME SWITCHES TO BE DISCUSSED*C*INE
          XT AND IN THE TONE DURATION.*E
   3  DT  30,0+/2,30+/40,0+/(PRESS THE SPACE*B*B*B*B*B----- BAR*B*B*B--- TO GO ON).*E
   4  EPI 30,39+/2,30+/1,37+/+/1+/PAGETURNER*E
   5  AA  (8+/)AA*E
   6  DE  30+/2*E
   7  BR  FR25*E
PRETNC*E
```

```
   1  DL   22,0+/40*E
   2  DT   23,0+/6,23+/40,0+/+/*E
   3  DT   23,0+/6,23+/40,0+/  (B)ASIC SETTINGS WERE CORRECT, BUT (TONE*C*INORM ON)/(OFF )WAS (ON )AND THE DURATION OF*C*
           IYOUR TONE WAS INCORRECT.  (S)OME FURTHER*E
   4  DT   ,0+/2,+/40,0+/REVIEW MIGHT BE HELPFUL. +P+R+E+S+S +S+P+.+C+E +B+ +R*E
   5  EPI  30,39+/2,30+/1,37+/+/1+/PAGETURNER*E
   6  AA   (8+/)AA*E
   7  BR   FR2*E
FR2*E
SS 1  NO   (COMMENT&  T)HIS IS THE START OF ACTUAL INSTRUCTIONAL MATERIAL.  (I)F THE STUDENT PERFORMS THE REQUIRED OPERAT
           ION*E
SS 2  NO   CORRECTLY, HE IS BRANCHED TO (FR)5.  (I)F HE HAS DIFFICULTY, HE IS BRANCHED TO (FR)3.*E
   3  PR   *E
   4  LD   0+/S1*E
   5  FN   SF+/5+/S0+/S30*E
   6  LD   0+/C1*E
   7  FN   SF+/4+/C1+/C30*E
   8  FN   CH+/K*E
   9  DE   0+/32*E
  10  DT   0,0+/2,0+/40,0+/            1. (POWER SWITCH*E
  11  DT   ,0+/2,+/40,0+/+/*E
  12  DT   ,0+/2,+/40,0+/    (F)IRST, TURN ON THE AUDIOMETER.  (T)HE*E
  13  DT   ,0+/2,+/40,0+/POWER SWITCH IS IN THE UPPER RIGHT-HAND*E
  14  DT   ,0+/2,+/40,0+/CORNER OF THE PANEL.*E
  15  DT   ,0+/2,+/40,0+/+/*E
  16  DT   ,0+/2,+/40,0+/    (T)URN ON*B*B(-- )THE POWER SWITCH NOW.*E
  17  DT   ,0+/2,+/40,0+/+/*E
  18  DT   ,0+/2,+/40,0+/    (I)F THE LIGHT BY THE POWER SWITCH CAME*E
  19  DT   ,0+/2,+/40,0+/ON, (PRESS THE LIGHT PEN HERE )- - +0*BO+0*BO.*E
  20  DT   ,0+/2,+/40,0+/+/*E
  21  DT   ,0+/2,+/40,0+/    (I)F NOT, (PRESS IT HERE )- - - - +0*BO+0*BO.*E
  22  EPP  500+/FR2*E
  23  NX   *E
  24  BR   LONG*E
  25  CAP  4,17,6,32+/F2*E
  26  BR   FR5*E
  27  CAP  4,21,6,32+/F2*E
  28  BR   FR3*E
  29  UN   F2*E
  30  DTI  28,0+/4,28+/40,0+/(Y)OU PRESSED THE LIGHT PEN IN THE WRONG*C*IPLACE.  (P)LEASE TRY IT AGAIN.*E
  31  EA   *E
FR3*E
SS 1  NO   (COMMENT&  A)S CAN BE SEEN, THIS FRAME PROVIDES ADDITIONAL HELP FOR TURNING ON THE AUDIOMETER.  (A )SLIDE (9FP
           )1(0 )SHOWS*E
SS 2  NO   HOW IT SHOULD BE DONE.  (M)ULTIPLE LEVELS OF THESE (')HELPS(' )ARE PROVIDED TO INSURE UNDERSTANDING.*E
   3  PR   *E
   4  FP1  105*E
   5  DE   0+/32*E
   6  DT   0,0+/2,0+/40,0+/    (Y)OU PROBABLY FLIPPED THE WRONG*E
   7  DT   ,0+/2,+/40,0+/SWITCH.  (T)HE POWER SWITCH IS INDICATED*E
   8  DT   ,0+/2,+/40,0+/IN THE SLIDE.  (F)LIP IT TO (ON)& THE POWER*E
   9  DT   ,0+/2,+/40,0+/LIGHT IS NEXT TO IT.*E
  10  DT   ,0+/2,+/40,0+/+/*E
  11  DT   ,0+/2,+/40,0+/    (I)F THE POWER LIGHT CAME ON, (PRESS THE*E
  12  DT   ,0+/2,+/40,0+/(LIGHT PEN HERE )- - - - - - - - - - +0*BO+0*BO.*E
  13  DT   ,0+/2,+/40,0+/+/*E
  14  DT   ,0+/2,+/40,0+/    (I)F NOT, (PRESS IT HERE )- - - - - +0*BO+0*BO.*E
  15  EPP  500+/FR3*E
  16  NX   *E
  17  BR   LONG*E
  18  CAP  4,11,4,35+/F3*E
  19  BR   FR5*E
  20  CAP 4,15,4,35+/F3*E
  21  BR  FR4*E
  22  UN  F3*E
  23  DTI 28,0+/4,28+/40,0+/(Y)OU PRESSED THE LIGHT PEN IN THE WRONG*C*IPLACE.  (P)LEASE TRY AGAIN.*E
  24  EA  *E
FR4*E
   1  PR  *E
   2  FP1 19*E
   3  DE  0+/32*E
   4  DT  0,0+/2,0+/40,0+/   (A)PPARENTLY YOU ARE STILL HAVING A*E
   5  DT  ,0+/2,+/40,0+/PROBLEM.  (T)HE SWITCH YOU SHOULD BE FLIP-*E
   6  DT  ,0+/2,+/40,0+/PING IS CIRCLED ON THE SLIDE.  (P)LEASE*E
   7  DT  ,0+/2,+/40,0+/TRY IT AGAIN.*E
   8  DT  ,0+/2,+/40,0+/+/*E
   9  DT  ,0+/2,+/40,0+/(I)F IT WORKS THIS TIME, PRESS THE LIGHT*E
  10  DT  12,0+/2,12+/40,0+/PEN HERE - +O*BO.*E
  11  DT  ,0+/2,+/40,0+/+/*E
  12  DT  ,0+/2,+/40,0+/(I)F IT STILL DOES NOT WORK, PRESS THE*E
  13  DT  ,0+/2,+/40,0+/LIGHT PEN HERE - +O*BO.*E
  14  EPP 500+/FR4*E
  15  NX  *E
  16  BR  LONG*E
  17  CAP 4,11,7,9+/F4*E
  18  BR  FR5*E
  19  CAP 4,17,7,15+/F4*E
  20  DTI 28,0+/4,28+/40,0+/(T)HERE SEEMS TO BE A PROBLEM WITH THE*C*IMACHINE.  (T)H PROCTOR HAS BEEN NOTIFIED.*E
  21  PM  ,0+/2,+/40,0+/(A)UDIOMETER STUDENT HAVING DIFFICULTY TURNING ON AUDIOMETER.  (A)SSISTANCE IS NEEDED.*E
  22  EA  *E
FR5*E
   1  PR  *E
   2  FP0 *E
   3  DE  0+/32*E
   4  DT  0,0+/2,0+/40,0+/   (T)HE (POWER SWITCH )IS ESPECIALLY IMPOR-*E
   5  DT  ,0+/2,+/40,0+/TANT BECAUSE IF IT IS NOT*B*B*B(--- )ON YOU CAN'T*E
   6  DT  ,0+/2,+/40,0+/GIVE A HEARING TEST WITH AN AUDIOMETER.*E
   7  DT  ,0+/2,+/40,0+/+/*E
   8  DT  ,0+/2,+/40,0+/   (I)N THIS CASE, THE POWER SWITCH*E
   9  DT  ,0+/4,+/40,0+/CONNECTS THE SIMULATOR TO THE COMPUTER,*C*IAND IF IT IS OFF*B*B*B(---), YOU WILL NOT BE ABLE*E
  10  DT  ,0+/2,+/40,0+/TO PROCEED (9)YOU WILL BE SIGNED OFF(0).*E
  11  DT  30,0+/2,30+/40,0+/   (PRESS THE SPACE*B*B*B*B*B----- BAR*B*B*B--- TO GO ON*E
  12  EPI 30,39+/2,30+/1,37+/+/1+/PGTRN*E
FR6*E
   1  PR  *E
   2  DE  0+/32*E
   3  FN  CH+/K*E
   4  FP1 104*E
   5  DT  0,0+/2,0+/40,0+/           2.  (THE TONE SWITCH*E
   6  DT  ,0+/2,+/40,0+/+/*E
   7  DT  ,0+/2,+/40,0+/   (T)O GIVE THE TONE TO A SUBJECT, YOU*E
   8  DT  ,0+/2,+/40,0+/PRESS DOWN THE (TONE )SWITCH (9)CIRCLED ON*E
   9  DT  ,0+/2,+/40,0+/THE SLIDE(0).*E
  10  DT  ,0+/2,+/40,0+/+/*E
  11  DT  ,0+/4,+/40,0+/   (N)OW, PRESS DOWN THE (TONE )SWITCH ON*C*ITHE (A)UDICMETER (S)IMULATOR.*E
  12  FN  CH+/A*E
  13  EP  ,0+/2,+/40,0+/400+/1+/FR6+/*E
  14  NX  *E
  15  BR  FR6A*E
$S16  NO  (COMMENT&  N)OTE THAT IN THE ABOVE CODING THERE ARE TWO FUNCTIONS.  (FN  CH=)/(K )GIVES INPUT CONTROL TO THE*E
$S17  NO  KEYBOARD& (FN  CH=)/(A )GIVES CONTROL TO THE AUDIOMETER.*E
FR6RE*E
   1  CA  (8+/)F6*E
   2  DE  24+/6*E
   3  DT   26,18+/2,26+/40,0+/+0 +K*E
   4  LR   FR7+/RR1*E
[illegible]  BR   WAIT1*E
F[illegible]E
   1  PR   *E
   2  FP1  107*E
   3  FP1  107*E
   4  DT   ,0+/2,+/40,0+/+/*E
   5  DT   ,0+/2,+/40,0+/   (I )HAVEN'T GOTTEN YOUR MESSAGE YET.*E
   6  DT   ,0+/2,+/40,0+/+/*E
   7  DT   ,0+/2,+/40,0+/   (F)IND THE SWITCH LABELED (TONE 9)CIRCLED*E
   8  DT   ,0+/2,+/40,0+/ON THE SLIDE(O )AND PRESS IT ALL THE WAY*E
   9  DT   ,0+/2,+/40,0+/DOWN.*E
  10  FN   CH+/A*E
  11  EP   ,0+/2,+/40,0+/300+/8+/FR6A+/*E
  12  NX   *E
  13  BR   FR6B*E
  14  CA   (8+/)6A*E
  15  DE   0+/16*E
  16  DE   4+/28*E
  17  DT   29,18+/2,29+/40,0+/+0 +K*E
  18  LR   FR7+/RR1*E
  19  BR   WAIT1*E
FR6B*E
   1  PR   *E
   2  FP1  98*E
   3  DE   0+/32*E
   4  DT   ,0+/2,+/40,0+/   (I)T SHOULDN'T BE THAT HARD.  (T)HE (TONE*E
   5  DT   ,0+/2,+/40,0+/SWITCH IS IN THE LOWER CENTER OF THE*E
   6  DT   ,0+/2,+/40,0+/(A)UDIOMETER (S)IMULATOR PANEL AND IS*E
   7  DT   ,0+/2,+/40,0+/CIRCLED IN THE SLIDE.*E
   8  DT   ,0+/2,+/40,0+/+/*E
   9  DT   ,0+/2,+/40,0+/   (P)RESS DOWN THE RIGHT SIDE OF THE*E
  10  DT   ,0+/2,+/40,0+/SWITCH AS FAR AS IT WILL GO.*E
  11  FN   CH+/A*E
  12  EP   ,0+/2,+/40,0+/350+/1+/FR6B+/*E
  13  NX   *E
  14  BR   FR6C+/S2+/1*E
  15  LD   1+/S2*E
  16  BR   RE*E
  17  CA   (8+/)6B*E
  18  DT   26,0+/6,26+/40,0+/   (T)HAT WASN'T SO HARD.  (Y)OU'LL BE USING*C*ITHIS SWITCH A LOT, SO YOU'LL GET MORE*C*IPRA
           CTICE WITH IT.*E
  19  LR   FR7+/RR1*E
  20  BR   WAIT2*E
FR6C*E
   1  DE   0+/32*E
   2  PM   ,0+/2,+/40,0+/(ASSISTANCE REQUIRED WITH AUDIOMETER )- (IT CANNOT BE TURNED ON).*E
   3  DT   10,0+/2,10+/40,0+/(T)HE PROCTOR HAS BEEN NOTIFIED.  (P)LEASE*E
   4  DT   12,0+/2,12+/40,0+/WAIT FOR ASSISTANCE.*E
   5  DT   28,0+/4,28+/40,0+/(P)RESS (SPACE BAR )WHEN THE (A)UDIOMETER HAS*C*IBEEN TURNED ON.*E
   6  EPI  30,39+/2,30+/1,37+/+/1+/*E
   7  NX   *E
   8  BR   RE*E
   9  AA   (8+/)ZZ*E
FR7*E
   1  PR   *E
   2  FP1  93*E
   3  DE   0+/32*E
   4  DT   0,0+/2,0+/40,0+/       3.  (TONE NORM ON)/(OFF SWITCH*E
   5  DT   ,0+/2,+/40,0+/+/*E
   6  DT   ,0+/2,+/40,0+/   (T)HE (TONE NORM ON)/(OFF )SWITCH, CIRCLED*E
  7  DT  ,0+/2,+/40,0+/IN THE SLIDE, DETERMINES WHETHER A TONE*E
  8  DT  ,0+/2,+/40,0+/IN THE (A)UDIOMETER EARPHONE IS NORMALLY*E
  9  DT  ,0+/2,+/40,0+/ON OR NORMALLY OFF.*E
 10  DT  ,0+/2,+/40,0+/+/*E
 11  DT  ,0+/2,+/40,0+/   (S)ET THIS SWITCH TO (TONE NORM OFF),*E
 12  DT  ,0+/2,+/40,0+/THEN*B*B*B*B(---- )PRESS DOWN THE (TONE )SWITCH.*E
 13  FN  CH+/A*E
 14  EP  ,0+/2,+/40,0+/500+/8+/FR7+/*E
 15  LD  B0+/B1*E
 16  CA  1(8+/)CA*E
 17  DE  26+/6*E
 18  DT  27,0+/2,27+/40,0+/        (F)INE.  (Y)OU'RE STARTED.*E
 19  LR  FR8+/RR1*E
 20  BR  WAIT1*E
 21  UN  F7*E
 22  FP1 108*E
 23  DT  ,0+/2,+/40,0+/+/*E
 24  DT  ,0+/2,+/40,0+/   (Y)OUR (TONE NORM ON)/(OFF )SWITCH IS*E
 25  DT  ,0+/2,+/40,0+/STILL SET TO (ON). (T)URN IT (OFF)& TRY AGAIN.*E
 26  BR  RE*E
 27  UN  UU*E
 28  BR  FR7A*E
FR7A*E
  1  PR  *E
  2  FP1 111*E
  3  DE  0+/32*E
  4  DT  0,0+/2,0+/40,0+/   (A)PPARENTLY YOU'RE HAVING A PROBLEM.*E
  5  DT  ,0+/2,+/40,0+/(T)HE SWITCHES ARE HIGHLIGHTED ON THE*E
  6  DT  ,0+/2,+/40,0+/SLIDE TO HELP YOU FIND THEM.*E
  7  DT  ,0+/2,+/40,0+/   (T)HE POWER SWITCH IS ON, BUT THE (TONE*E
  8  DT  ,0+/2,+/40,0+/(NORM ON)/(OFF )SWITCH IN THE CENTER OF THE*E
  9  DT  ,0+/2,+/40,0+/PANEL SHOULD BE SET TO (TONE NORM OFF).*E
 10  DT  12,0+/2,12+/40,0+/   (A)FTER YOU SET THE SWITCHES PROPERLY,*E
 11  DT  ,0+/2,+/40,0+/PRESS THE (TONE )SWITCH IN THE CENTER ALL*E
 12  DT  ,0+/2,+/40,0+/THE WAY DOWN.*E
 13  DT  ,0+/2,+/40,0+/+/*E
 14  DT  ,0+/2,+/40,0+/   (G)O AHEAD AND DO IT NOW.*E
 15  DT  ,0+/2,+/40,0+/+/*E
 16  PA  50*E
 17  EP  ,0+/2,+/40,0+/500+/8+/FR7A+/*E
 18  NX  *E
 19  BR  LONG*E
 20  CA  1(8+/)CA*E
 21  DE  26+/6*E
 22  DTI 26,0+/4,26+/40,0+/(Y)OU FINALLY GOT IT.  (T)HAT WASN'T SO*C*IHARD, WAS IT(/*E
 23  LR  FR8+/RR1*E
 24  BR  WAIT1*E
 25  WA  (8+/)WA*E
 26  DE  26+/6*E
 27  DTI 28,0+/4,28+/40,0+/(C)OME, NOW, IT ISN'T THAT HARD.  (R)EAD*C*ITHE INSTRUCTIONS CAREFULLY AND TRY AGAIN*E
 28  UN  UU*E
 29  DTI 26,0+/2,26+/40,0+/(S)YSTEM PROBLEM.  (T)RY AGAIN.*E
 30  EA  *E
```

```
**LSTCSE

**AUDIO 001 FR52               =08=68          1 00137
FR52*E
$$ 1  NO  (COMMENT&  T)HIS SEQUENCE, TO (RESP), IS TYPICAL OF THE CODING USED FOR THIS UNIT.  (F)OR THIS ONE, THE STUDEN
          T IS*E
$$ 2  NO  DIRECTED TO GIVE A TONE OF -5 D(B), 2000 (H)Z, IN THE RIGHT EAR, AS PART OF THE HEARING TEST.  (A)LL PANEL DIA
          LS ARE*E
$$ 3  NO  TESTED& IF ANY ARE WRONG, A MESSAGE IS DISPLAYED (9DTI)'S(0 )WHICH TELLS THE STUDENT WHAT HE SHOULD HAVE DONE
          AND*E
$$ 4  NO  INSTRUCTS THE STUDENT TO TRY AGAIN.*E
   5  PR  *E
   6  FN  CH+/A*E
(3)01(3)66*E
   1  DTI 0,0+/4,0+/17,0+/-5 (DB).*E
   2  DTI 4,0+/28,4+/11,0+/+/*E
(3)02(3)66*E
   1  LD  0+/S3*E
   2  LR  (3)08(3)66+/RR0*E
   3  LR  RESP+/RR5*E
   4  LR  HDN10+/RR1*E
   5  LR  (3)02(3)66+/RR4*E
   6  FN  SF+/3+/C20*E
   7  EP  ,0+/2,+/40,0+/100+/8+/FR52+/*E
   8  LD  C0+/C21*E
   9  LD  80+/B1*E
  10  NX  *E
  11  DTI 10,0+/16,10+/11,0+/*1+A+A+A+A+A+A+A+A+A+A+A*C*I*I*0  (YOUR*C*I  PATIENT*C*I  IS*C*I  WAITING*E
  12  AD  1+/C11*E
  13  BR  (3)02(3)66*E
  14  CA  11710010+/CA*E
  15  DTI 28,12+/4,28+/28,12+/+/*E
  16  BR  RESP*E
  17  AA  (8+/)A1*E
  18  DTI 4,0+/28,4+/11,0+/+/*E
  19  DTI 5,0+/3,5+/11,0+/  (ERRORS*C*I*1)CCCCCCCCCCC*E
  20  AA  1171(8+/)A2*E
  21  BR  (3)06(3)66*E
  22  AA  (8)1(8+/)A3*E
  23  BR  (3)03(3)66*E
  24  AA  (8+/)W1*E
  25  AD  1+/C7*E
  26  DTI ,0+/4,+/11,0+/(C)H.1 (HEAR*C*ILEVEL)-GIVE*E
  27  DTI ,0+/3,+/11,0+/-5 (DB).*E
(3)03(3)66*E
   1  AA  (88)7(8+/)A4*E
   2  BR  (3)04(3)66*E
   3  AA  (8+/)W2*E
   4  AD  1+/C6*E
   5  DTI ,0+/2,+/11,0+/(C)H.1 (FREQ).*E
   6  DTI ,0+/3,+/11,0+/(S)ET ON 2000*E
(3)04(3)66*E
   1  AA  (888)1(8+/)A5*E
   2  BR  (3)05(3)66*E
   3  AA  (8+/)W3*E
   4  AD  1+/C8*E
   5  DTI ,0+/2,+/11,0+/(C)H.1 (OUTPUT*E
   6  DTI ,0+/3,+/11,0+/(S)ET (RIGHT*E
(3)05(3)66*E
   1  AA  1(8+/)A6*E
   2  BR  (3)06(3)66*E
   3  AA  (8+/)W4*E
   4  AD  1+/C5*E
   5  DTI ,0+/3,+/11,0+/(TONE NORM*E
(3)06(3)66*E
   1  AA  (8888)0010+/A7*E
   2  BR  (3)07(3)66*E
   3  AA  (8+/)W5*E
   4  DTI ,0+/6,+/11,0+/(C)H.2 DIALS&*C*I(SISI), OR*C*I(TONE WARBLE*E
   5  AD  1+/C9*E
(3)07(3)66*E
   1  DTI 30,12+/2,30+/28,12+/(CORRECT AND GIVE TONE AGAIN).*E
   2  BR  (3)02(3)66*E
(3)08(3)66*E
   1  DTI 16,39+/2,16+/1,39+/(N*E
   2  LR  FR53+/RR1*E
   3  LD  0+/S30*E
   4  BR  WAIT1*E
RESP*E
$$ 1  NO  (COMMENT&  T)HIS SEQUENCE, UP TO (HDN)10, IS THE TIMING SEQUENCE.  (I)T WAITS FOR THE STUDENT TO RELEASE THE T
          ONE SWITCH*E
$$ 2  NO  AND THEN CALCULATES THE DURATION OF THE TONE BY THE FORMULA (C)23 - (C)20 (= C)22 - (C)21.  (T)HE DURATION AND
          , IF NEEDED, ERROR*E
$$ 3  NO  MESSAGE, ARE THEN DISPLAYED, AND THE PROGRAM CONTINUES TO THE NEXT FRAME.*E
   4  FN  SF+/3+/C23*E
   5  EP  ,0+/2,+/40,0+/60+/1+/RESP+/*E
   6  NX  *E
   7  BR  RESPNX*E
   8  AA  (8+/)AA*E
   9  AD  1+/C4*E
  10  LD  B0+/B2*E
  11  LD  C0+/C22*E
  12  LR  RESP1+/RR5*E
  13  BR  RESP1+/S30+/1*E
  14  BR  RR1*E
RESP1*E
   1  LD  C23+/C24*E
   2  SB  C20+/C24*E
   3  AD  C22+/C24*E
   4  SB  C21+/C24*E
   5  FN  MV+/C24+/+/B4+/*E
   6  FN  MV+/'.'+/B4,4+/IA*E
   7  FN  MV+/B4,3,4+/B4,0+/*E
TIMEND*E
   1  BR  OVER+/C24+/G+/40*E
   2  BR  UNDER+/C24+/L+/20*E
   3  DTI 28,17+/2,28+/23,17+/+/*E
   4  DTI 30,12+/2,30+/28,12+/      (TONE DURATION      SEC).*E
   5  DTI 30,31+/2,30+/4,31+/B4*E
   6  BR  RRO*E
OVER*E
   1  AD  1+/C2*E
   2  DTI 28,17+/2,28+/23,17+/(TONE DURATION      SEC).*E
   3  DTI 28,31+/2,28+/4,31+/B4*E
   4  DTI 30,12+/2,30+/28,12+/  (TOO LONG). 2-4 SEC.IS RIGHT.*E
   5  BR  RRO*E
UNDER*E
   1  AD  1+/C3*E
   2  DTI 28,17+/2,28+/23,17+/(TONE DURATION      SEC).*E
   3  DTI 28,31+/2,28+/4,31+/B4*E
   4  DTI 30,12+/2,30+/28,12+/ (TOO SHORT).2-4 SEC. IS RIGHT.*E
   5  BR  RRO*E
RESPNX*E
   1  AD  1+/C3*E
   2  BR   RESPB+/S30+/1*E
   3  DTI  6,0+/16,6+/11,0+/*I*I(PANEL COR)-*C*I(RECT), (BUT*C*ITONE TOO*C*ISHORT).*C*I*I(GIVE IT*C*IAGAIN).*E
   4  DTI  ,0+/7,+/11,0+/*I(DISREGARD*C*IPATIENT*C*IRESPONSE).*E
   5  LR   RESPA+/RR5*E
   6  BR   RR1*E
RESPA*E
   1  BR   RR4*E
RESPB*E
   1  DTI  6,0+/18,6+/11,0+/*I*I(PANEL COR)-*C*I(RECT), BUT*C*CTONE TOO*C*ILONG.*C*I*I(S)UBJECT MAY*C*INOT WANT TO*C*IRES
           POND.*E
   2  BR   RR4*E
HDN10*E
$$ 1  NO   (COMMENT&  T)HIS IS THE CODING FOR THE PATIENT DISPLAYED ON THE DISPLAY SCREEN WITH HIS HAND DOWN.*E
   2  DTI  0,20+/9,0+/19,11+/*1*I*I*I F*B(1*B*R+T*B*I*I3 *R1*B*R+T*B*I*0).*178*B*I*IF*B*I*IF*B*B*B*B*B*R*RF*B*IF*B*IUVW*B
           *B*B*IMN+F+G*B*B*B*R*R*R*B+V+U*B1*B*B*R*R*R*R(-)E(ST*B*B)E(/*B*B*B)L*BK*B*E
   3  DTI  9,17+/6,9+/19,11+/*1*I*I*I*I*I(&*B*R*R3*R*R)S*RXYFOJ(3*B*B*B*B*R)MN+F+GR*B*I*I(3*R+S+T*I)R*I*I+2*B*I*I'*B*B*B*
           RF*B*B*B*B*B*B*BT+E*I=*B*R*R'*B*B*B+J*B+0*B*R*RFLM*B*B*I+O*B*I+E*R+J*B (&+U*B*I+M*B*I)S*B*B9*B*R*R*R*E
   4  DTI  15,16+/6,15+/20,11+/*1*I*I*I*I*I(&*B*R*R3*R*R)9*B*R*R(& *I*I*I)F*B*I*IF  *R+E*B*R*R+E*B*R+E(3)S*B*B*I*I(&*B*I*
           I)9   =U F*B*RF*B*B*B*B*R'*B*R*R+2 *R'*B*I*I=*B*B*B*B*BE+0*E
   5  DTI  23,10+/5,21+/24,10+/*1 *I*I+I+J*B*R*R+K+LEE+0*B*R*R*R(&*B*I*I)I*B*I*II*B+K*IC*R+N*B(&*B*R*R3*R*R)F*B*I*I*IEE*R
           +K*B+N*B*B*I(3*B*I*I+O+A*R+I+J*B*B*R*R+AT*B*I*IU)UVWXY*R*RO*I+O*B+O+P*B*B*B*B*B*B*B*B*B*R*RUVWXY*R  F*E
   6  DTI  26,10+/4,26+/3[illegible]10+/*1*I+L*R*R+I+J   *I(3*B*I*I)=*I+A+A*B*RT*B*R+A*B*RT*E
   7  BR   RR5*E
HUP10*E
$$ 1  NO   (COMMENT&  T)HIS CODING DISPLAYS A RAISED HAND ON THE SUBJECT.*E
   2  DTI  5,11+/28,0+/20,0+/*1(-)'*B(L6*B*B*B*I*I)' '*B*I*I5*B*B*B+O*ITT*B*B*I+I+J*B*B*I*IZ*B*R10T*I*IT*I*IT9*B*R*R(&*B*
           R*R3*R*R)S*RX*B*B*B*B*B*B*B*B*I*I*I*I*IT*I*IT*I*IT*I*IT*I*IMA*RSF*B*R*RF*B*R*RF*I*I*I*I*I*I*B*B*B*B*B*B*B+K+LE
           EEEEE*E
   3  DE   28+/4*E
   4  BR   RR5*E
HANDDN*E
$$ 1  NO   (COMMENT&  T)HIS IS THE PATIENT PLACED AT A DIFFERENT POSITION ON THE DISPLAY SCREEN.*E
   2  DTI  0,23+/9,0+/17,14+/*1*I*I*I F*B(1*B*R+T*B*I*I3 *R1*B*R+T*B*I*0).*178*B*I*IF*B*I*IF*B*B*B*B*B*R*RF*B*IF*B*IUVW*B
           *B*B*IMN+F+G*B*B*B*R*R*R*B+V+U*B1*B*B*R*R*R*R(-)E(ST*B*B)E(/*B*B*B)L*BK*B*E
   3  DTI  9,20+/6,9+/19,14+/*1*I*I*I*I*I(&*B*R*R3*R*R)S*RXYFOJ(3*B*B*B*B*R)MN+F+GR*B*I*I(3*R+S+T*I)R*I*I+2*B*I*I'*B*B*B*
           RF*B*B*B*B*B*B*BT+E*I=*B*R*R'*B*B*B+J*B+0*B*R*RFLM*B*B*I+O*B*I+E*R+J*B (&+U*B*I+M*B*I)S*B*B9*B*R*R*R*E
   4  DTI  15,19+/6,15+/20,14+/*1*I*I*I*I*I(&*B*R*R3*R*R)9*B*R*R(& *I*I*I)F*B*I*IF  *R+E*B*R*R+E*B*R+E(3)S*B*B*I*I(&*B*I*
           I)9   =U F*B*RF*B*B*B*B*R'*B*R*R+2 *R'*B*I*I=*B*B*B*B*BE+0*E
   5  DTI  23,13+/5,21+/24,13+/*1 *I*I+I+J*B*R*R+K+LEE+0*B*R*R*R(&*B*I*I)I*B*I*II*B+K*IC*R+N*B(&*B*R*R3*R*R)F*B*I*I*IEE*R
           +K*B+N*B*B*I(3*B*I*I+O+A*R+I+J*B*B*R*R+AT*B*I*IU)UVWXY*R*RO*I+O*B+U+P*B*B*B*B*B*B*B*B*B*R*RUVWXY*R  F*E
   6  DTI  26,13+/4,26+/27,13+/*1*I+L*R*R+I+J   *I(3*B*I*I)=*I+A+A*B*RT*B*R+A*B*RT*E
   7  BR   RR5*E
HANDUP*E
   1  DTI  5,14+/28,5+/11,12+/*1(-)'*B(L6*B*B*B*I*I)' '*B*I*I5*B*B*B+O*ITT*B*B*I+I+J*B*B*I*IZ*B*R10T*I*IT*I*IT9*B*R*R(&*B
           *R*R3*R*R)S*RX*B*B*B*B*B*B*B*B*I*I*I*I*IT*I*IT*I*IT*I*IT*I*IMA*RSF*B*R*RF*B*R*RF*I*I*I*I*I*I*B*B*B*B*B*B*B+K+L
           EEEEEE*E
   2  DE   28+/4*E
   3  BR   RR5*E
TRANSO*E
   1  TR   0+/FR1*E
GRAV*E
$$ 1  NO   (COMMENT&  T)HIS CODING DISPLAYS AN AUDIOGRAM FORM ON THE SCREEN.  (T)HE STUDENT INDICATES WHERE HE WILL PLACE
           A*E
$$ 2  NO   CIRCLE ON HIS FORM BY PRESSING THE LIGHT PEN TO THE PROPER COORDINATES ON THIS DISPLAYED GRID.*E
   3  DTI  9,24+/2,9+/12,24+/(FREQUENCY HZ*E
   4  DTI  11,19+/1,11+/21,19+/*2*R1*I(2*B*R)5 (2*I)5*B*R(0 )5*I(0*B*R0 )1*I(0*B*R0*I0*R2*IC*B*R0*I0*R4*I0*B*R0*I0*R8*I0*
           B*R0*I*20*E
   5  DTI  12,19+/1,12+/21,19+/*1AAAAAAAAAAAAAAAAAAAAA*E
   6  DTI  13,19+/1,13+/21,19+/*1FI*B+B   I*B+B   I*B+B   I*B+B   I*B+B   I*B+B   I*B+B+E*E
   7  DTI  14,17+/1,14+/23,17+/*1(C*2)1*B*R(0*I*1)FI*B+B   I*B+B   I*B+B   I*B+B   I*B+B   I*B+B   I*B+B+E*B*B*B*B*B*B*B*B*B*B*
           B*B*B*B*B*B*B*B*B*B*BCCCCCCCCCCCCCCCCCCCCCC*E
   8  DTI  15,18+/2,15+/22,18+/*20*1FI* +   I* +   I* +   I* +   I* +   I* +   I* +B+B*B*B*B*B*B*B*B*B*B*B*B*B*B*B*B*
```

```
        B*B*B*B+A+A+A+A+A+A+A+A+.+.+.+.+ + + + + + + + + *E
  9  DTI 17,18+/1,17+/22,18+/*21*B*R(O*I*1)FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B+E*B*B*B*B*B*B*B*B*B*B*B*B
         *B*B*B*B*B*B*B*BCCCCCCCCCCCCCCCCCCCCCC*E
 10  DTI 18,18+/2,18+/22,18+/*2(O*1)FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B+E*B*B*B*B*B*B*B*B*B*B*B*B*B*
         B*B*B*B*B+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A*E
 11  DTI 20,18+/1,20+/22,18+/*23*B*R(O*I*1)FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B+E*B*B*B*B*B*B*B*B*B*B*B*B
         *B*B*B*B*B*B*B*BCCCCCCCCCCCCCCCCCCCCCC*E
 12  DTI 21,15+/2,21+/25,15+/(DB *2)O*1FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B .I*B+B  I*B+B+E*B*B*B*B*B*B*B*B*B*B*B*B*B
         *B*B*B*B*B*B+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A*E
 13  DTI 23,18+/1,23+/22,18+/*25*B*R(O*I*1)FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B+E*B*B*B*B*B*B*B*B*B*B*B*B
         *B*B*B*B*B*B*B*BCCCCCCCCCCCCCCCCCCCCCC*E
 14  DTI 24,18+/2,24+/22,18+/*2(Z*1)FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B+E*B*B*B*B*B*B*B*B*B*B*B*B*B*
         B*B*B*B*B+A+A+A+A+A+A+A+A+.+.+.+.+.+ + + + + + + + *E
 15  DTI 26,18+/1,26+/22,18+/*27*B*R(O*I*1)FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B+E*B*B*B*B*B*B*B*B*B*B*B*B
         *B*B*B*B*B*B*B*BCCCCCCCCCCCCCCCCCCCCCC*E
 16  DTI 27,18+/2,27+/22,18+/*2+X*1FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B+E*B*B*B*B*B*B*B*B*B*B*B*B*B*B*B
         *B*B*B*B+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A*E
 17  DTI 29,18+/1,29+/22,18+/*29*B*R(O*I*1)FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B+E*B*B*B*B*B*B*B*B*B*B*B*B
         *B*B*B*B*B*B*B*BCCCCCCCCCCCCCCCCCCCCCC*E
 18  DTI 30,17+/2,30+/23,17+/*2+IO*1FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B+E*B*B*B*B*B*B*B*B*B*B*B*B*B*B*
         B*B*B*B*B+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A*E
 19  BR  RR5*E
 20  EPP 600+/*E
 21  AAP 18,19,14,21+/ZZ*E
 22  DTI 15,23+/2,15+/1,23+/*2+A*E
 23  EPP 500+/*E
 24  AAP 18,19,14,21+/ZZ*E
 25  DTI 19,29+/1,19+/1,29+/*2+J*E
 26  EPP 300+/*E
 27  AAP 18,19,14,21+/ZZ*E
 28  DTI 18,32+/2,18+/1,32+/*2+H*E
 29  EPP 400+/*E
 30  AAP 18,19,14,21+/ZZ*E
 31  DTI 26,32+/1,26+/1,32+/*2+K*E
 32  DTI 26,23+/2,26+/1,23+/*2+A*E
 33  DTI 17,26+/1,17+/1,26+/*2+D*E
 34  DTI 15,29+/1,15+/1,29+/*2+F*E
 35  DTI 15,35+/1,15+/1,35+/*2+G*E
 36  EPP 1000+/*E
 37  AAP 18,19,14,21+/ZZ*E
 38  BR  GRAM*E
FR53*E
SS 1  NO  (COMMENT&  H)ERE THE STUDENT STATES THE THRESHOLD HE HAS FOUND FROM THE PASSES HE HAS JUST MADE AT 2000 (H)Z.*
          E
   2  PR  *E
   3  DE  0+/32*E
   4  FN  CH+/K*E
   5  DTI 0,0+/4,0+/30,0+/(N)OW YOU HAVE ALL THE RESPONSES*C*IYOU NEED TO DECIDE THRESHOLD.*E
   6  DTI ,0+/8,+/30,0+/*I(W)HAT DO YOU THINK IS THE*C*ITHRESHOLD AT THIS FREQUENCY(/*C*I*I9U)SE AS YOUR CRITERION THE*E
   7  DTI ,0+/6,+/30,0+/LOWEST INTENSITY AT WHICH A*C*IMAJORITY OF YES RESPONSES WERE*C*IOBTAINED.(0  ---- )DB (9)TYPE I
          N*C*I       DTI ,+/2+/30,+/YOUR ANSWER(0*E
   8  DTI ,0+/2,+/30,0+/YOUR ANSWER.*E
   9  DTI 0,35+/2,0+/5,35+/(,    ,*B*B*B*B*B*I)X   X*E
  10  DTI 2,32+/18,2+/8,32+/40 (Y   Y*I*I*B*B*B*B*B*B*B)30 (Y   Y*I*I*B*B*B*B*B*B*B)20 (Y   Y*I*I*B*B*B*B*B*B*B)15
          (Y Y Y*I*B*B*B*B*B*B*B*I)10 (Y Y Y*I*I*B*B*B*B*B*B)5 (Y N Y*I*I*B*B*B*B*B*B)0 (N N N*I*I*B*B*B*B*B*B*B*
          B)-5 (N   N*E
  11  DTI 18,37+/2,18+/1,37+/(,*B*R)X*E
  12  EPI 16,11+/2,16+/3,11+/500+/3+/FR53*E
  13  FN  ED+/+/+/+/ *E
  14  NX  *E
  15  DTI 21,0+/11,21+/30,0+/*I*I(P)LEASE TYPE AN ANSWER,*C*IEVEN IF YOU HAVE TO GUESS.*E
  16  DTI 28,0+/2,28+/30,0+/(B)E SURE TO ENTER IT.*E
 17  BR   RE*E
 18  CA   5+/CA*E
 19  BR   FR54*E
 20  WA   10+/WA*E
 21  DL   20,0+/30*E
 22  DTI  21,0+/4,21+/30,0+/(Y)OU ARE LOOKING FOR THE*C*IMAJORITY, THE LOWEST (DB )LEVEL*E
 23  DTI  ,0+/2,+/40,0+/FOR 2*B(- )OUT OF 3*B(- )YES RESPONSES, NOT FOR*E
 24  DTI  ,0+/4,+/40,0+/THE LOWEST FOR ALL.  (H)ERE YOU NEEDED*C*ITHE THIRD PASS TO GET THIS.  (T)RY AGAIN.*E
 25  UN   U2*E
 26  DL   20,0+/30*E
 27  DE   25+/7*E
 28  DTI  21,0+/4,21+/30,0+/(Y)OU ARE LOOKING FOR THE *C*IMAJORITY, OR THE LOWEST (DB*E
 29  DTI  25,0+/2,25+/40,0+/LEVEL FOR 2*B(- )OUT OF 3*B(- )RESPONSES.  (N)OTE*E
 30  DTI  ,0+/4,+/40,0+/THAT HERE YOU NEEDED THE THIRD PASS OVER*C*ITHRESHOLD TO OBTAIN THIS.  (T)RY AGAIN.*E
 31  UN   U3*E
 32  DTI  21,0+/4,21+/30,0+/+/*E
 33  DE   25+/7*E
 34  DL   24,0+/40*E
 35  DTI  25,0+/4,25+/40,0+/(L)OOK FOR THE LOWEST*B*B*B*B*B*B(------ )DB LEVEL AT WHICH 2*B(-*C*I)OUT OF 3*B(- )YES RESP
          ONSES WERE OBTAINED.*E
 36  DTI  ,0+/3,+/40,0+/*I(T)RY AGAIN.*E
 37  UN   U4*E
 38  BR   FR54*E
FR54*E
$$ 1  NO   (COMMENT&  T)HIS MESSAGE IS DISPLAYED AROUND THE DISPLAYED AUDIOGRAM.*E
   2  PR   *E
   3  DE   0+/32*E
   4  DTI  0,0+/6,0+/40,0+/(R)IGHT. (T)HERE WERE 2 OUT OF THREE YES*C*IRESPONSES (9)A MAJORITY(0 )AT 5 DB. (S)INCE*C*IYOU
           FOUND THIS THRESHOLD TO BE 5 DB AT*E
   5  DTI  ,0+/2,+/40,0+/2000 (HZ), PRESS THE LIGHT PEN WHERE THE*E
   6  DTI  ,0+/4,+/13,0+/CIRCLE SHOULD*C*IGO.*E
   7  LR   FR54X+/RR5*E
   8  BR   GRAM*E
FR54X*E
   1  DTI  17,29+/1,17+/1,29+/*R*2+G*E
   2  EPP  400+/FR54*E
   3  NX   *E
   4  DTI  ,0+/14,+/14,0+/*I*I*1AAAAAAAAAAAAA*C*I*O(M)AKE SURE THE*C*ILIGHT PEN IS*C*IOVER A LINE.*C*I(M)OVE IT AROUND*C
           *IA BIT.*E
   5  BR   RE*E
   6  CAP  1,16,1,32+/CA*E
   7  BR   FR54C*E
   8  WAP  1,15,1,32+/WA*E
   9  DTI  ,0+/6,+/14,0+/(Y)OU HIT -5,*C*IBUT YOU WANT*C*I(=)5. (T)RY AGAIN.*E
  10  UN   U1*E
  11  DE   0+/8*E
  12  DTI  8,0+/20,8+/14,0+/+/*E
  13  DTI  28,0+/4,28+/14,0+/+/*E
  14  DTI  0,0+/6,0+/40,0+/(R)EMEMBER, YOU MARK THE INTERSECTION OF*C*I5 DB AND 2000 (H)Z. (I)N THIS CASE, IT*C*IWOULD BE
           HALFWAY BETWEEN THE 0 DB AND*E
  15  DTI  ,0+/6,+/14,0+/10 (DB). LINES.*E
  16  DTI  ,0+/3,+/14,0+/*I(T)RY IT AGAIN.*E
  17  UN   U2*E
  18  DTI  11,0+/1,11+/14,0+/*1AAAAAAAAAAAAAA*E
  19  DTI  13,0+/19,13+/13,0+/(I )KNOW THIS*C*IIS TOUGH.*C*I*I(B)E SURE YOU*C*IARE AIMING*C*IAT THE RIGHT*C*ISPOT - YOU*C
           *IMAY BE TOO*C*IHIGH.*E
  20  UN   U4*E
  21  DTI  13,0+/19,13+/13,0+/(M)OVE THE*C*ILIGHT PEN*C*IUP AND DOWN*C*ITHE LINE.*E
  22  UN   U3*E
  23  BR   FR54C*E
FR54C*E
   1  PR   *E
   2  DE  0+/8*E
   3  DTI 16,32+/1,16+/1,32+/*2+F*E
   4  DTI 8,0+/20,8+/14,0+/+/*E
   5  DTI 28,0+/4,28+/14,0+/+/*E
   6  DTI 0,0+/2,0+/40,0+/(T)HE CIRCLE MARKS THE PROPER SPOT.*E
   7  DTI 3,0+/6,3+/40,0+/(P)UT A CIRCLE AT THAT LOCATION ON YOUR*C*IAUDIOGRAM (9)IN RED PENCIL(0).*C*I(P)RESS (SPACE BA
          R )WHEN FINISHED.*E
   8  DE  7+/2*E
   9  DTI 9,0+/6,9+/14,0+/(P)RESS (SPACE*C*IBAR )WHEN*C*IFINISHED.*E
  10  EPI 30,39+/2,30+/1,37+/+/1+/PGTRN*E
FR55*E
   1  PRR *E
   2  FN  CH+/A*E
   3  LD  0+/S30*E
   4  DE  0+/32*E
   5  LR  FR55T+/RR5*E
   6  BR  HANDDR*E
FR55T*E
$S 1  NO  (COMMENT&  W)ITH THIS, THE STUDENT STARTS TO TEST THE NEXT FREQUENCY, 4000 (H)Z.*E
   2  FP1 10*E
   3  DTI 0,0+/4,0+/31,0+/(S)TAYING WITH THE RIGHT EAR,*C*ICHANGE THE (FREQUENCY )TO 4000.*E
   4  DTI ,0+/6,+/22,0+/(S)INCE WE STILL*C*IESTIMATE A THRESHOLD*C*IOF 10 DB  AT THIS*E
   5  DTI ,0+/4,+/22,0+/FREQUENCY, GIVE THE*C*IFIRST TONE AT 40 DB.*E
   6  EPP 0+/*E
   7  PR  *E
(3)02(3)67*E
   1  LD  0+/S3*E
   2  LR  (3)08(3)67+/RR0*E
   3  LR  RESP+/RR5*E
   4  LR  HANDDR+/RR1*E
   5  LR  (3)02(3)67+/RR4*E
   6  FN  SF+/3+/C20*E
   7  EP  ,0+/2,+/40,0+/200+/8+/FR55+/*E
   8  LD  C0+/C21*E
   9  LD  B0+/B1*E
  10  NX  *E
  11  DTI 10,0+/16,10+/11,0+/*1+A+A+A+A+A+A+A+A+A+A+A*C*I*I*0  (YOUR*C*I  PATIENT*C*I  IS*C*I  WAITING*E
  12  AD  1+/C11*E
  13  BR  (3)02(3)67*E
  14  CA  1A910010+/CA*E
  15  DTI 4,0+/24,4+/22,0+/+/*E
  16  DTI 28,12+/4,28+/28,12+/+/*E
  17  BR  HANDUR*E
  18  AA  (8+/)A1*E
  19  DTI 4,0+/28,4+/11,0+/+/*E
  20  DTI 5,0+/3,5+/11,0+/  (ERRORS*C*I*1)CCCCCCCCCCC*E
  21  AA  1A91(8+/)A2*E
  22  BR  (3)06(3)67*E
  23  AA  (8)A(8+/)A3*E
  24  BR  (3)03(3)67*E
  25  AA  (8+/)W1*E
  26  AD  1+/C7*E
  27  DTI ,0+/4,+/11,0+/(C)H.1 (HEAR*C*ILEVEL)-GIVE*E
  28  DTI ,0+/3,+/11,0+/40 (DB).*E
(3)03(3)67*E
   1  AA  (88)9(8+/)A4*E
   2  BR  (3)04(3)67*E
   3  AA  (8+/)W2*E
   4  AD  1+/C6*E
   5  DTI ,0+/2,+/11,0+/(C)H.1 (FREQ).*E
   6  DTI ,0+/3,+/11,0+/(S)ET ON 4000*E
(3)04(3)67*E
```

```
   1  AA   (888)1(8+/)A5*E
   2  BR   (3)05(3)67*E
   3  AA   (8+/)W3*E
   4  AD   1+/C8*E
   5  DTI  ,0+/2,+/11,0+/(C)H.1 (OUTPUT*E
   6  DTI  ,0+/3,+/11,0+/(S)ET (RIGHT*E
(3)05(3)67*E
   1  AA   1(8+/)A6*E
   2  BR   (3)06(3)67*E
   3  AA   (8+/)W4*E
   4  AD   1+/C5*E
   5  DTI  ,0+/3,+/11,0+/(TONE NORM*E
(3)06(3)67*E
   1  AA   (8888)0010+/A7*E
   2  BR   (3)07(3)67*E
   3  AA   (8+/)W5*E
   4  DTI  ,0+/6,+/11,0+/(C)H.2 DIALS&*C*I(SISI), OR*C*I(TONE WARBLE*E
   5  AD   1+/C9*E
(3)07(3)67*E
   1  DTI 30,12+/2,30+/28,12+/(CORRECT AND GIVE TONE AGAIN).*E
   2  BR   (3)02(3)67*E
(3)08(3)67*E
   1  LR   FR55Z+/RR5*E
   2  EPP 10+/*E
   3  PR   *E
   4  BR   HDN10*E
FR55Z*E
SS 1  NO   (COMMENT&  A )RUNNING TABLE OF THE RESULTS OF EACH HEARING LEVEL TESTED IS KEPT IN THE UPPER RIGHTHAND CORNER
           OF*E
SS 2  NO   THE DISPLAY SCREEN.*E
   3  DTI 0,35+/2,0+/10,30+/(,*B*I)X*E
   4  DTI 2,32+/20,2+/8,32+/40 (Y*E
   5  DTI ,34+/6,+/6,34+/*E
   6  DTI 6,28+/2,6+/1,28+/+/*E
FR56*E
   1  PR   *E
   2  FPO *E
   3  EPP 0+/*E
   4  PR   *E
   5  FN   CH+/A*E
(3)01(3)68*E
   1  DTI 0,0+/4,0+/17,0+/*I*I(N)OW 30 (DB).*E
   2  DTI 4,0+/28,4+/11,0+/+/*E
(3)02(3)68*E
   1  LD   0+/S3*E
   2  LR   (3)08(3)68+/RR0*E
   3  LR   RESP+/RR5*E
   4  LR   HDN10+/RR1*E
   5  LR   (3)02(3)68+/RR4*E
   6  FN   SF+/3+/C20*E
   7  EP   ,0+/2,+/40,0+/100+/8+/FR56+/*E
   8  LD   C0+/C21*E
   9  LD   B0+/B1*E
  10  NX   *E
  11  DTI 10,0+/16,10+/11,0+/*1+A+A+A+A+A+A+A+A+A+A+A*C*I*I*0  (YOUR*C*I  PATIENT*C*I  IS*C*I  WAITING*E
  12  AD   1+/C11*E
  13  BR   (3)02(3)68*E
  14  CA   18910010+/CA*E
  15  BR   HUP10*E
  16  AA   (8+/)A1*E
  17  DTI 4,0+/26,4+/11,0+/+/*E
  18  DTI 5,0+/3,5+/11,0+/  (ERRORS*C*I*1)CCCCCCCCCCC*E
  19  AA   1891(8+/)A2*E
  20  BR   (3)06(3)68*E
  21  AA   (8)8(8+/)A3*E
  22  BR   (3)03(3)68*E
  23  AA   (8+/)W1*E
  24  AD   1+/C7*E
  25  DTI ,0+/4,+/11,0+/(C)H.1 (HEAR*C*ILEVEL)-GIVE*E
  26  DTI ,0+/3,+/11,0+/30 (DB).*E
(3)03(3)68*E
   1  AA   (88)9(8+/)A4*E
   2  BR   (3)04(3)68*E
   3  AA   (8+/)W2*E
   4  AD   1+/C6*E
   5  DTI ,0+/2,+/11,0+/(C)H.1 (FREQ).*E
   6  DTI ,0+/3,+/11,0+/(S)ET ON 4000*E
(3)04(3)68*E
   1  AA   (888)1(8+/)A5*E
   2  BR   (3)05(3)68*E
   3  AA   (8+/)W3*E
   4  AD   1+/C8*E
   5  DTI ,0+/2,+/11,0+/(C)H.1 (OUTPUT*E
   6  DTI ,0+/3,+/11,0+/(S)ET (RIGHT*E
(3)05(3)68*E
   1  AA   1(8+/)A6*E
   2  BR   (3)06(3)68*E
   3  AA   (8+/)W4*E
   4  AD   1+/C5*E
   5  DTI ,0+/3,+/11,0+/(TONE NORM*E
(3)06(3)68*E
   1  AA   (8888)0010+/A7*E
   2  BR   (3)07(3)68*E
   3  AA   (8+/)W5*E
   4  DTI ,0+/6,+/11,0+/(C)H.2 DIALS&*C*I(SISI), OR*C*I(TONE WARBLE*E
   5  AD   1+/C9*E
(3)07(3)68*E
   1  DTI 30,12+/2,30+/28,12+/(CORRECT AND GIVE TONE AGAIN).*E
   2  BR   (3)02(3)68*E
(3)08(3)68*E
   1  DTI 4,32+/2,4+/8,32+/30 (Y*E
**AUDIO 001 RECAP            FR170         30 00137
RECAP*E
$$ 1  NO   (T)HE FOLLOWING SEQUENCE DISPLAYS A SUMMARY OF THE STUDENT'S PERFORMANCE SINCE FRAME 16 AND PROVIDES AN OPPORT
           UNITY FOR REVIEW OF TOPICS IN WHICH ERRORS WERE MADE.*E
   2  PRR  *E
   3  FPO  *E
   4  DE   0+/32*E
   5  DT   0,0+/2,0+/40,0+/(YOUR PERFORMANCE ON FINDING THRESHOLDS&*E
   6  LD   C4+/C1*E
   7  AD   C5+/C1*E
   8  AD   C6+/C1*E
   9  AD   C7+/C1*E
  10  AD   C8+/C1*E
  11  AD   C9+/C1*E
  12  LD   C4+/C10*E
  13  MP   100+/C10*E
  14  DV   C1+/C10*E
  15  LD   (N)UMBER OF TONES GIVEN     (3 C)ORRECT    *C*I*I (P)ERCENT CORRECT        (3 T)IME-OUTS    +/)B5*E
  16  FN   MV+/C1+/NC+/,22+/*E
  17  FN   MV+/C4+/NC+/,36+/*E
  18  FN   MV+/C10+/NC+/,60+/*E
  19  FN   MV+/C11+/NC+/,78+/*E
  20  DT   3,0+/5,3+/40,0+/B5*E
  21  LD     (3 E)RRORS WITH TONE NORM SWITCH        *C*I*I  (3 E)RRORS WITH (C)H. 1 (FREQUENCY        +/)B5*E
  22  FN   MV+/C5+/NC+/,37+/*E
  23  FN   MV+/C6+/NC+/,80+/*E
  24  DT   9,0+/5,9+/40,0+/B5*E
  25  LD     (3 E)RRORS WITH (C)H.1 (HEARING LEVEL      *C*I*I  3 E)RRORS WITH (C)H. 1 (OUTPUT           +/)B5*E
  26  FN   MV+/C7+/NC+/,37+/*E
  27  FN   MV+/C8+/NC+/,80+/*E
  28  DT   15,0+/5,15+/40,0+/B5*E
  29  LD     (3 E)RRORS WITH (C)H.2 DIALS, (SISI), OR*C*I      (TONE WARBLE                    +/)B5*E
  30  FN   MV+/C9+/NC+/,75+/*E
  31  DT   21,0+/4,21+/40,0+/B5*E
  32  LD   (3 T)ONES TOO LONG        *C*I*I(3 T)ONES TOO SHORT       +/B5*E
  33  FN   MV+/C3+/NC+/,44+/*E
  34  FN   MV+/C2+/NC+/,19+/*E
  35  DT   26,0+/5,26+/40,0+/B5*E
  36  DTI  26,24+/6,26+/16,24+/*1CCCCCCCCCCCCCCC*B*B*B*B*B*B*B*B*B*B*B*B*B*BF*I*BF*0(PRESS SPACE BAR*B*B*B*B*B*B*B
           *B*B*B*B*B*B*B*B*I*I*1)F*0(TO CONTINUE).*E
  37  EPI  30,39+/2,30+/1,37+/+/1+/RECAP*E
  38  AA   (8+/)AA*E
RECAP1*E
   1  LD   C2+/C29*E
   2  AD   C3+/C29*E
   3  MP   100+/C29*E
   4  DV   C1+/C29*E
   5  DE   0+/32*E
   6  BR   RECAPT+/C29+/G+/15*E
RECAPA*E
   1  BR   RECAP3+/C10+/L+/92*E
   2  BR   RECAP2+/C10+/L+/96*E
   3  DT   0,0+/8,0+/40,0+/(Y)OU DID WELL ON FINDING THRESHOLDS.  (I)'M*C*ISURE YOU WILL CONTINUE THE GOOD WORK.*C*I*I(B)
           ECAUSE THIS IS THE END OF THIS SECTION.*E
   4  DT   7,0+/8,7+/40,0+/AND BEFORE YOU GO ON TO A REVIEW OF THE*C*IPROCEDURE YOU USED, YOU MAY REVIEW SOME*C*ITOPICS A
           LREADY COVERED.  (U)SE LIGHT PEN(&*E
   5  DT   14,0+/10,14+/40,0+/ A. (R)EVIEW SELECTED TOPICS (9P)RESS FOR*C*I       INDEX(0   )-   +,*B,*C*I*I B. (L)OOK AT
           PERFORMANCE SUMMARY AGAIN- +,*B,*C*I*I C. (G)O ON - +,*B,*E
   6  EPP  900+/RECAPA*E
   7  NX   *E
   8  DT   30,0+/2,30+/40,0+/(PRESS THE LIGHT PEN TO A LIGHTED SQUARE).*E
   9  BR   RE*E
  10  CAP 4,21,3,11+/GO*E
  11  BR  FR166*E
  12  CAP 4,15,3,19+/RE*E
  13  LR  TRREC1+/RR1*E
  14  TR  0+/INDEX*E
  15  CAP 4,18,2,38+/SU*E
  16  BR  RECAP*E
  17  UN  UU*E
  18  DT  30,0+/2,30+/40,0+/(PRESS THE LIGHT PEN TO A LIGHTED SQUARE).*E
  19  BR  RE*E
RECAP2*E
   1  PR  *E
   2  DE  0+/32*E
   3  DT  0,0+/8,0+/40,0+/(Y)OU DID FAIRLY WELL ON FINDING*C*ITHRESHOLDS, BUT YOU SHOULDN'T HAVE MADE*C*ISO MANY ERRORS.
          *E
   4  DT  8,0+/8,8+/40,0+/(T)HE NEXT SECTION WILL DEAL WITH THE*C*IMETHOD YOU USED TO FIND THRESHOLDS.*C*I*I(A)T THIS PO
          INT, YOU MAY WISH TO REVIEW*E
   5  DT  15,0+/8,15+/40,0+/SOME AREAS IN WHICH YOU MADE ERRORS*C*I(9)USE THE LIGHT PEN(06*E
   6  DT  20,0+/10,20+/40,0+/ A. (R)EVIEW SPECIFIC TOPICS ON PANEL*C*I      OPERATION (9P)RESS FOR INDEX(0 )-  +,*B,*C*I*
          I B. (L)OOK AT PERFORMANCE SUMMARY AGAIN- +,*B,*C*I*I*E
   7  DT  28,0+/2,28+/40,0+/ C. (G)O ON - +,*B,*E
   8  EPP 900+/RECAP2*E
   9  NX  *E
  10  DT  30,0+/2,30+/40,0+/(PRESS LIGHT PEN TO A LIGHTED SQUARE).*E
  11  BR  RE*E
  12  CAP 4,27,3,11+/GO*E
  13  BR  FR166*E
  14  CAP 4,21,10,30+/RE*E
  15  LR  TRREC2+/RR1*E
  16  TR  0+/INDEX*E
  17  CAP 4,24,2,38+/SU*E
  18  BR  RECAP*E
  19  UN  UU*E
  20  DT  30,0+/2,30+/40,0+/(PRESS THE LIGHT PEN ON A LIGHTED SQUARE).*E
  21  BR  RE*E
RECAP3*E
   1  PR  *E
   2  DE  0+/32*E
   3  DT  0,0+/8,0+/40,0+/(Y)OU REALLY DIDN'T DO AS WELL AS YOU*C*ISHOULD HAVE.  (I)T WOULD BE A GOOD IDEA*C*ITO REVIEW
          THOSE TOPICS WITH WHICH YOU*E
   4  DT  6,0+/8,6+/40,0+/HAD TROUBLE BEFORE YOU GO ON, OR YOU*C*IMIGHT WANT TO GO THROUGH THE PREVIOUS*C*ITESTING PROCE
          SSES AGAIN.*E
   5  DT  13,0+/6,13+/40,0+/(B)ECAUSE YOU HAVE TO BE ABLE TO DO THE*C*IMECHANICS OF TESTING PERFECTLY, BE SURE*C*IYOU KN
          OW EVERYTHING UP TO THIS POINT*E
   6  DT  19,0+/2,19+/40,0+/BEFORE YOU GO ON.*E
   7  DT  19,0+/2,19+/40,0+/BEFORE YOU GO ON.  (9U)SE LIGHT PEN(60*E
   8  DT  22,0+/10,22+/40,0+/ A. (R)EVIEW SELECTED TOPICS - +,*B,*C*I B. (G)O THROUGH THRESHOLD FINDING AGAIN +,*B,*C*I
          C. (S)EE PERFORMANCE SUMMARY AGAIN - +,*B,*E
   9  DT  28,0+/2,28+/40,0+/ D. (G)O ON (9)ONLY IF YOU KNOW EVERYTHING(0+,*B),*E
  10  EPP 900+/RECAP3*E
  11  NX  *E
  12  DT  30,0+/2,30+/40,0+/(PRESS LIGHT PEN AGAINST A LIGHTED SQUARE*E
  13  BR  RE*E
  14  CAP 2,28,5,35+/GO*E
  15  BR  FR166*E
  16  CAP 2,22,10,25+/RE*E
  17  LR  TRREC3+/RR1*E
  18  TR  0+/INDEX*E
  19  CAP 2,24,10,30+/RP*E
  20  BR  FR143*E
  21  CAP 2,26,5,35+/SU*E
  22  BR  RECAP*E
  23  UN   UU*E
  24  DT   30.0+/2.30+/40.0+/ (PRESS THE LIGHT PEN ON A LIGHTED SQUARE*E
  25  BR   RE*E
RECAPT*E
   1  BR   RECAPA+/S29+/1*E
   2  LD   C6+/C20*E
   3  LD   C7+/C21*E
   4  LD   C8+/C22*E
   5  LD   C9+/C23*E
   6  LD   C10+/C24*E
   7  DE   0+/32*E
   8  DT   4.0+/8.4+/40.0+/  (F)ROM YOUR PERFORMANCE. IT APPEARS THAT*C*IYOU ARE STILL HAVING SOME DIFFICULTY IN*C*IGIVIN
           G THE TONE FOR THE RIGHT LENGTH OF*E
   9  DT   10.0+/8.10+/40.0+/TIME (9)2 TO 4 SECONDS(0).*C*I*I  (B)ECAUSE. AS YOU HAVE SEEN. THIS IS AN*C*IIMPORTANT SKILL
           . SOME MORE PRACTICE*C*ISTILL BE USEFUL.*E
  10  DT   17.0+/2.17+/40.0+/MAY STILL BE USEFUL.*E
  11  DT   20.0+/8.20+/40.0+/  (G)IVE A SERIES OF TONES WITHOUT SETTING*C*ITHE PANEL.  (P)LEASE WAIT UNTIL (I )TELL YOU*C
           *IHOW LONG THE TONE WAS BEFORE YOU GIVE TH*E
  12  DT   24.0+/8.24+/40.0+/HOW LONG THE TONE WAS BEFORE YOU GIVE*C*ITHE NEXT.*C*I*I  (B)EGIN NOW.*E
  13  LD   0+/C6*E
  14  FN   SF+/4+/C6+/C10*E
  15  LR   TRRECT+/RR1*E
  16  TR   0+/PRAC1A*E
RECAPU*E
   1  LD   C20+/C6*E
   2  LD   C21+/C7*E
   3  LD   C22+/C8*E
   4  LD   C23+/C9*E
   5  LD   C24+/C10*E
   6  LD   1+/S29*E
   7  BR   RECAPA*E
FR166*E
$$ 1  NC   (COMMENT6  T)HIS STARTS THE REVIEW SECTION IN WHICH THRESHOLD FINDING TECHNIQUES ARE DISCUSSED AND TESTED.*E
   2  PRR  *E
   3  FN   CH+/K*E
   4  DT   0.31+/2.0+/9.31+/*1F*0   (.*B*I)X   *R(.*B*I)X*E
   5  DT   2.31+/20.2+/9.31+/*1F*040      (Y*B*B*B*B*B*B*B*B*B*I*I*1)F*030 (Y   Y*B*B*B*B*B*B*B*B*B*I*I*1)F*020 (Y   Y*B*B
           *B*B*B*B*B*B*B*I*I*1)F*015   (Y Y*B*B*B*B*B*B*B*B*B*I*I*1)F*010 (Y Y Y*B*B*B*B*B*B*B*E
   6  DT   12.31+/10.12+/9.31+/*1F*0 5 (Y N Y*B*B*B*B*B*B*B*B*B*I*I*1)F *00 (N N N*B*B*B*B*B*B*B*B*B*I*I*1)F*0-5 (N   N*E
   7  DT   18;31+/14.18+/9.31+/      (.*B*R)X*E
   8  DTI  0.0+/10.0+/30.0+/(L)OOK AT THE TABLE.*C*I*I(F)OR EACH FREQUENCY. YOU GET*C*ITWO OR THREE THRESHOLD*C*IESTIMATE
           S BY STARTING ABOVE,*E
   9  DTI  .0+/10.+/30.0+/*E
  10  DTI  9.0+/10.9+/30.0+/BELOW. AND THEN ABOVE THE*C*IESTIMATED THRESHOLD.*C*I*I(R)ECALL THAT FOR THE DESCENDING*B*B*B
           *B*B*B*B*B*B*B(----------*C*I)PASS YOU USUALLY START WITH AN*C*I*E
  11  DTI  18.0+/10.18+/30.0+/INTENSITY THAT IS (-----)D(B*C*I)ABOVE THE ESTIMATED THRESHOLD.*E
  12  EPI  18.18+/2.18+/4.18+/600+/4+/FR166*E
  13  FN   ED+/+/+/+/ *E
  14  NX   *E
  15  DTI  25.0+/6.25+/40.0+/(H)ERE. THE THIRD PASS WAS STARTED HOW*C*IMANY (DB )ABOVE THE THRESHOLD ESTIMATED IN*C*ITHE
           SECOND PASS(/*E
  16  BR   RE*E
  17  CA   30+/CA*E
  18  BR   FR167*E
  19  UN   UU*E
  20  BR   FR166A*E
FR166A*E
   1  DTI  0.0+/8.0+/30.0+/(W)E INITIALLY ESTIMATED THAT THE*C*ISUBJECT HAD A THRESHOLD OF 0 D(B*C*I)AND STARTED THE FIRS
           T DESCEND-*C*IING PASS WITH 30 (DB).*E
   2  DTI  8.0+/10.8+/30.0+/*I*I(T)HUS. YOU USUALLY START YOUR*C*IDESCENDING PASS AT A (DB )LEVEL*C*ITHAT IS (----DB )ABO
           VE THE*C*IESTIMATED THRESHOLD.*E
   3  DTI  16.0+/16.16+/30.0+/*E
```

3

```
   4  EPI 14,8+/2,14+/3,8+/500+/3+/FR166A*E
   5  FN  ED+/+/+/+/ *E
   6  NX  *E
   7  DTI 22,0+/6,22+/30,0+/(W)ELL, WHAT DO YOU THINK*C*IIT IS(/*E
   8  BR  RE*E
   9  CA  30+/CA*E
  10  BR  FR167*E
  11  UN  U1*E
  12  DTI 22,0+/6,22+/30,0+/(I)F YOU ESTIMATED 0 D(B )AS THE*C*ITHRESHOLD AND STARTED WITH 30*C*I(DB), HOW FAR ABOVE THE
          ESTIMATE*E
  13  DTI 28,0+/2,28+/30,0+/DO YOU START(/*E
  14  BR  RE*E
FR167*E
   1  PR  *E
   2  DTI 0,0+/32,0+/30,0+/(R)IGHT.  (Y)OU START 30 D(B )ABOVE*C*ITHE ESTIMATED THRESHOLD.*C*I*I(R)ECALL THAT FOR THE DE
          SCENDING*C*IPASSES YOU STARTED BY*C*ISUCCESSIVELY DECREASING THE*C*IHEARING LEVELS IN (-----DB*C*I)INTERVALS.*
          E
   3  EPI 11,18+/2,11+/3,18+/500+/3+/FR167*E
   4  FN  ED+/+/+/+/ *E
   5  NX  *E
   6  DTI 30,8+/2,30+/32,8+/  (W)HAT IS THE INTERVAL(/*E
   7  BR  RE*E
   8  CA  10+/CA*E
   9  CB  TEN+/CB*E
  10  BR  FR168*E
  11  WA  5+/WA*E
  12  WB  FIV(8+/)WB*E
  13  DTI 16,0+/16,16+/30,0+/*R(-------------------------------*C*IN)OT AT THE BEGINNING.*C*I*I(Y)OU WILL DESCEND IN 5 (D
          B*C*I)STEPS LATER.  (N)OW LOOK AT*C*ITHE FIRST (9)DESCENDING(0 )PASS.*C*I(H)OW MANY (DB )SEPARATE THE*C*IFIRST
           TWO HEARING LEVELS*C*ITESTED(/   T)RY AGAIN.*E
  14  UN  U1*E
  15  DTI 16,0+/16,16+/30,0+/*R(--------------------------------*C*IN)O.  (L)OOK AT THE FIRST*C*I(9)DESCENDING(0 )PASS.
          (W)HAT IS*C*ITHE DIFFERENCE IN (DB )BETWEEN*C*ITHE FIRST AND THE SECOND AND*C*ITHE SECOND AND THIRD TESTED*C*I
          HEARING LEVELS (9)FROM THE*C*ITOP(0/      T)RY AGAIN.*E
  16  DTI 29,6+/3,29+/20,6+/*I(T)RY AGAIN.*E
  17  UN  U2*E
  18  DTI 30,7+/2,30+/33,7+/  (P)LEASE TRY AGAIN, AND (THINK).*E
  19  UN  U3*E
  20  DTI 30,7+/2,30+/33,7+/  (H)OW MUCH IS 30 MINUS 20(/*E
  21  BR  RE*E
FR168*E
   1  PR  *E
   2  DTI 16,0+/16,16+/30,0+/*1D D D D D D D D D D D D D D D*C*0(S)URE, START WITH 10 (DB*C*I)INTERVALS.*C*I(F)OR EACH D
          ESCENDING PASS YOU*C*IDESCEND BY 10 (DB )HOW MANY*C*ITIMES(/*E
   3  DTI 23,0+/4,23+/30,0+/DESCEND BY THIS 10 D(B*C*I)INTERVAL HOW MANY TIMES(/*E
   4  DE  27+/5*E
   5  EPI 26,30+/2,26+/3,30+/500+/3+/FR168*E
   6  FN  ED+/+/+/+/ *E
   7  NX  *E
   8  DT  30,0+/2,30+/40,0+/   (H)OW MANY TIMES(/*E
   9  BR  RE*E
  10  CA  2+/CA*E
  11  CB  TWO+/CB*E
  12  BR  FR168A*E
  13  WA  1+/WA*E
  14  WB  ON(8+/)WB*E
  15  DT  30,0+/2,30+/40,0+/(Y)OU DESCEND BY 10 (DB )MORE THAN ONCE.*E
  16  WA  3+/WA*E
  17  WB  THR+/WB*E
  18  DTI 17,0+/5,17+/30,0+/(Y)OU GIVE THREE TONES WHICH*C*IARE SEPARATED BY 10 (DB*E
  19  DTI 21,0+/2,21+/30,0+/STEPS, BUT HOW MANY TIMES*B*B*B*B*B(------*E
  20  DT  23,0+/9,23+/40,0+/IN EACH*B*B*B*B(---- )PASS DO YOU DECREASE BY THESE*C*I10 (DB )INTERVALS(/*E
  21  WA   5+/W1*E
  22  WB   6+/W1*E
  23  WB   7+/W1*E
  24  WB   8+/W1*E
  25  DTI 17,0+/6,17+/30,0+/(I)'M NOT LOOKING FOR THE TOTAL*C*INUMBER OF STEPS, BUT FOR THE*C*INUMBER OF TIMES YOU DECRE
          ASE*E
  26  DT   23,C+/9,23+/40,0+/BY A 10 (DB )JUMP IN A DESCENDING PASS.*E
  27  UN   U1*E
  28  DTI 17,0+/13,17+/30,0+/(N)OT CORRECT.*C*I(L)OOK AT THE TABLE. (H)OW*C*IMANY TIMES DID YOU DESCEND*C*IBY 10 D(B )IN
          TERVALS ON EITHER*C*ITHE FIRST OR THIRD PASS(/*E
  29  DTI 28,0+/2,28+/40,0+/(9L)OOK AT THOSE LEVELS WITH THE (Y)'S(0*E
  30  UN   U2*E
  31  DT   28,0+/4,28+/40,0+/(H)OW MANY TIMES WAS (HEARING LEVEL )DIAL*C*ICHANGED BY 10 (DB )ON THE LAST PASS(/*E
  32  UN   U3*E
  33  DT   28,0+/4,28+/40,C+/(H)OW MANY TIMES WAS IT CHANGED BY 10 DB*C*ISTEPS, NOT*B*B*B(--- )TWO STEPS OF 5 DB(/*E
  34  UN   U4*E
  35  DT   28,0+/4,28+/40,0+/(I)N LAST PASS, 10 DB STEPS WERE 40 TO 30*C*IAND 30 TO 20.  (H)OW MANY TIMES IS THIS(/*E
  36  UN   U5*E
  37  DT   28,0+/4,28+/40,0+/(I)T WAS 2 TIMES, AS YOU CAN SEE.  (R)IGHT(/*E
  38  PA   30*E
  39  BR   PR1*E
  40  BR   RE*E
FR168A*E
   1  PR   *E
   2  DTI 0,0+/30,0+/30,0+/(R)IGHT.  (Y)OU DECREASE BY 10*C*I(DB )STEPS TWO TIMES, FOR*C*IEFFICIENCY.*C*I*I(A)FTER THE T
          HIRD TONE, YOU*C*ISTART TO DESCEND IN*C*I     (DB )STEPS.*E
   3  DE   20+/12*E
   4  EPI 11,0+/2,11+/4,0+/500+/4+/FR168A*E
   5  FN   ED+/+/+/+/ *E
   6  NX   *E
   7  DTI 14,0+/18,14+/30,0+/*R(-------------------------------*C*IW)HAT SIZE STEPS DO YOU USE*C*INOW(/*E
   8  BR   RE*E
   9  CA   5+/CA*E
  10  CB   FIV+/CB*E
  11  BR   FR169*E
  12  WA   10+/WA*E
  13  WB   TEN+/WB*E
  14  DTI 14,0+/18,14+/30,0+/*1DDDDDDDDDDDDDDDDDDDDDDDDDDDDDD*C*I*I*I*E
  15  DTI 19,0+/8,19+/30,0+/(Y)OU DECREASE BY 10 (DB )TWICE,*C*ITHEN CHANGE.  (T)RY AGAIN.*E
  16  UN   UU*E
  17  DTI 14,0+/18,14+/30,0+/*1DDDDDDDDDDDDDDDDDDDDDDDDDDDDDD*C*I*I*I*I*0(W)HAT IS THE DIFFERENCE BETWEEN*C*I(DB )LEVELS
           BELOW 10 (DB )ON THE*C*ITABLE(/  T)RY AGAIN.*E
  18  UN   U2*E
  19  DTI 26,0+/6,26+/40,0+/(H)OW MUCH IS 10 MINUS 5(/*E
  20  BR   RE*E
FR169*E
   1  PR   *E
   2  DTI 0,0+/32,0+/30,0+/(R)IGHT.  (A)FTER DESCENDING IN*C*I10 (DB )STEPS TWICE YOU*C*IDECREASE BY 5 (DB )INCREMENTS.*
          C*I*I(T)HE DESCENDING PASS IS*C*ICONTINUED UNTIL YOU OBTAIN*C*I(------ )CONSECUTIVE (NO 9)OR*C*ILACK OF(O )RES
          PONSES.*E
   3  EPI 11,1+/2,11+/3,1+/500+/3+/FR169*E
   4  FN   ED+/+/+/+/ *E
   5  NX   *E
   6  DTI 28,0+/4,28+/30,0+/(H)OW MANY CONSECUTIVE (N*C*I)RESPONSES DID YOU GET(/*E
   7  BR   RE*E
   8  CA   2+/CA*E
   9  CB   TWO+/CB*E
  10  BR   FR170*E
  11  WA   1+/WA*E
  12  WB   ONE+/WB*E
  13  DTI 15,0+/17,15+/30,0+/*1DDDDDDDDDDDDDDDDDDDDDDDDDDDDD*C*0(Y)OU CAN SEE THAT MORE THAN*C*IONE (NO )RESPONSE WAS O
          BTAINED*C*IBEFORE STARTING BACK UP.*C*I(T)RY AGA*E
  14  DTI 22,0+/2,22+/30,0+/(T)RY AGAIN.*E
  15  UN  UU*E
  16  DTI 15,0+/17,15+/30,0+/*1DDDDDDDDDDDDDDDDDDDDDDDDDDDDDD*C*0(H)OW MANY (NO)'S ARE IN THE*C*IFIRST, DESCENDING COLUM
          N(/*C*IT)RY AGAIN.*E
  17  BR  RE*E
FR170*E
   1  PR  *E
   2  DE  0+/32*E
   3  DTI 0,33+/2,0+/7,33+/*1F*0   (,*B*I)X*E
   4  DTI 2,33+/20,2+/7,33+/*1F*030 (Y*I*I*B*B*B*B*B*1)F*020 (Y*I*I*B*B*B*B*B*1)F*010 (Y*I*I*B*B*B*B*B*1)F*0 5 (Y*I*I*B*
          B*B*B*B*1)F*0 0 (Y Y*B*B*B*B*B*B*B*I*I*1)F*0-5 (Y Y*B*B*B*B*B*B*B*I*I*1)F*0*B-10 (N*E
   5  DTI 16,33+/2,16+/7,33+/*1F*0      (,*B*R)X*E
   6  DTI 0,0+/12,0+/32,0+/(C)ORRECT. (T)HE DESCENDING PASS IS*C*ICONTINUED UNTIL 2 CONSECUTIVE*C*I(NO)'S ARE OBTAINED.
           (I)T IS LIKELY*C*ITHAT THE SUBJECT WOULD NOT*E
   7  DTI 8,0+/10,8+/32,0+/RESPOND BELOW THAT LEVEL.*C*I*I(N)OW LOOK AT THE SEQUENCE HERE.*C*I(T)HE DESCENDING PASS HAD
          TO BE*C*ISTOPPED AFTER REACHING      (DB*E
   8  DTI 17,0+/10,17+/32,0+/EVEN THOUGH YOU HAD NOT GOTTEN*C*ITWO (NO )RESPONSES.*E
   9  EPI 15,23+/2,15+/3,23+/600+/3+/FR170*E
  10  FN  ED+/+/+/+/ *E
  11  NX  *E
  12  DT  30,0+/2,30+/40,0+/(A)T WHAT (DB )LEVEL DOES IT STOP(/*E
  13  BR  RE*E
  14  CA  -10+/CA*E
  15  DL  21,0+/40*E
  16  DTI 22,0+/6,22+/40,0+/(R)IGHT.  (Y)OU CONTINUE DESCENDING UNTIL*C*IYOU REACH -10 (DB 9)THE BOTTOM OF THE*C*ISCALE(
          0 )OR TWO CONSECUTIVE (NO )RESPONSES,*E
  17  DTI ,0+/2,+/40,0+/WHICHEVER COMES FIRST.*E
  18  LR  FR171+/RR1*E
  19  PA  20*E
  20  BR  PRESS*E
  21  WA  10+/WA*E
  22  WB  TEN+/WB*E
  23  DL  21,0+/40*E
  24  DTI 23,0+/6,23+/40,0+/(I)T LOOKS LIKE YOU FORGOT THE MINUS SIGN.*C*I(T)RY AGAIN.*E
  25  AA  (8+/)11*E
  26  WA  -5+/W2*E
  27  DT  23,0+/4,23+/40,0+/(N)O. THIS IS THE START OF THE ASCENDING*C*IPASS.  (W)HAT IS THE BOTTOM OF THE FIRST(/*E
  28  UN  UU*E
  29  DT  23,0+/6,23+/40,0+/(N)O.  (W)HAT IS THE LOWEST (DB )LEVEL ON THE*C*I(C)H. 1 (HEARING LEVEL )DIAL(/  T)RY AGAIN.
          *E
  30  BR  RE*E
```

```
**AUDIO 004                               00137
AUDIO*E
   1  BR   INTRO*E
REVIEW*E
$$ 1  NO   (COMMENT&  )THIS PROVIDES THE STUDENT WITH THE OPPORTUNITY TO REVIEW ANY PREVIOUS MATERIAL HE HAS HAD IN THE C
           OURSE.  (I)T MAY BE ACCESSED AT ANY TIME DURING THIS UNIT.*E
$$ 2  NO   COMMENT-  ALSO PROVIDED ARE BRIEF COMMENTS CONCERNING PROCEDURES USED IN THRESHOLD FINDING IN THE EVENT THAT T
           HE STUDENT WANTS TO CHECK ON HIS MEMORY.*E
   3  PR   *E
   4  FN   CH+/K*E
   5  DE   0+/32*E
   6  DT   0,18+/20,0+/40,0+/(REVIEW*C*I*IP)RESS LIGHT PEN AGAINST WHAT YOU WANT TO*C*IREVIEW(&*C*I*I+,*B), (D)ESCENDING
           PASS*C*I*I+,*B, (A)SCENDING PASS*C*I*I+,*B, (T)HIRD PASS*C*I*I+,*B, (T)HRESHOLD DETERMINATION*E
   7  DT   20,0+/8,20+/40,0+/+,*B, (S)EQUENCE OF (F)REQUENCIES*C*I*I+,*B, (G)O THROUGH PREVIOUS SECTION FOR*C*I  COMPLETE
            REVIEW.*E
   8  DT   30,0+/2,30+/40,0+/+,*B, (P)RESS WHEN FINISHED.*E
   9  EPP  400+/REVIEW*E
  10  NX   *E
  11  DTI  30,0+/2,30+/40,0+/(P)RESS LIGHT PEN AGAINST ALIGHTED SQUARE.*E
  12  BR   RE*E
  13  AAP  2,8,1,0+/DE*E
  14  BR   DESC*E
  15  AAP  2,11,1,0+/AS*E
  16  BR   ASC*E
  17  AAP  2,14,1,0+/TH*E
  18  BR   THRD*E
  19  AAP  2,17,1,0+/SH*E
  20  BR   THRESH*E
  21  AAP  2,20,30,0+/FR*E
  22  BR   FREQ*E
  23  AAP  4,23,30,0+/RE*E
  24  TR   1+/FR166*E
  25  AAP  2,30,1,0+/FI*E
  26  DE   0+/32*E
  27  FN   CH+/A*E
  28  DTI  0,0+/10,0+/10,0+/(I)'M*C*I READY.*C*I  GIVE*C*I   THE*C*I    TONE.*E
  29  BR   HDN*E
  30  UN   UU*E
  31  DTI  30,0+/2,30+/40,0+/(P)RESS LIGHT PEN AGAINST ALIGHTED SQUARE*E
  32  BR   RE*E
DESC*E
   1  DE   2+/30*E
   2  DT   3,0+/8,3+/40,0+/(DESCENDING PASS )-*C*I*I  (D)ECREASE BY 10 DB FIRST TWO DECREASES,*C*IBY 5 DB THEREAFTER UNTI
           L YOU OBTAIN 2*C*I*E
   3  DT   10,0+/2,10+/40,0+/CONSECUTIVE (NO )RESPONSES OR UNTIL -10DB.*E
   4  DT   10,0+/2,10+/40,0+/CONSECUTIVE (NO )RESPONSES.*E
   5  DT   ,0+/6,+/40,0+/*I  (R)EMEMBER LEVEL OF LOWEST (YES )RESPONSE.*C*I*I  (R)EMEMBER TO START 30 DB ABOVE*C*IESTIMAT
           ED THRESHOLD.*E
   6  DT   18,0+/2,18+/40,0+/ESTIMATED THRESHOLD.*E
   7  BR   RET*E
ASC*E
   1  DE   2+/30*E
   2  DT   3,0+/10,3+/40,0+/(ASCENDING PASS )-*C*I*I  (S)TART 5 DB ABOVE WHERE YOU STOPPED THE*C*IDESCENDING PASS.*E
   3  DT   11,0+/8,11+/40,0+/  (I)NCREASE BY 5 DB AT ALL TIMES UNTIL*C*IYOU OBTAIN 2 CONSECUTIVE (YES )RESPONSES.*C*I*I
           (R)EMEMBER THE LEVEL OF THE LOWEST (YES).*E
   4  BR   RET*E
THRD*E
   1  DE   2+/30*E
   2  DT   3,0+/8,3+/40,0+/(THIRD PASS )-*C*I*I  (N)EEDED IF TWO OBTAINED THRESHOLD*C*IESTIMATES DO NOT AGREE.  (S)TART 3
           0 DB*E
   3  DT   10,0+/2,10+/40,0+/ABOVE HIGHER OF PREVIOUS 2 THRESHOLDS.*E
   4  DT   13,0+/2,13+/40,0+/  (S)EE (DESCENDING PASS )FOR FURTHER INFO.*E
   5  DT  15,0+/6,15+/40,0+/  (R)EMEMBER THAT AT THE END OF THIS PASS*C*IYOU DETERMINE THE THRESHOLD FOR THE*C*IFREQUENC
          Y, PLOT IT ON THE AUDIOGRAM, AND*E
   6  DT  ,0+/2,+/40,0+/GO ON TO THE NEXT FREQUENCY.*E
   7  BR  RET*E
THRESH*E
   1  DE  2+/30*E
   2  DT  3,0+/8,3+/40,0+/(THRESHOLD DETERMINATION )-*C*I*I  (D)ETERMINED BY THE LOWEST 2 OUT OF 3*C*ILEVELS WHERE (YES
          )WAS OBTAINED.*E
   3  DT  11,0+/6,11+/40,0+/  (Y)OU SHOULD BE ABLE TO REMEMBER EACH OF*C*ITHE THREE THRESHOLD ESTIMATES AND*C*IDETERMINE
           THE FINAL THRESHOLD FROM THEM.*E
   4  DT  18,0+/6,18+/40,0+/  (T)HE SEQUENCE OF PASSES IS DESCENDING,*C*ITHEN ASCENDING, FINALLY DESCENDING (9)IF*C*INEE
          DED(0).*E
   5  DT  25,0+/4,25+/40,0+/  (D)ETERMINE FINAL THRESHOLD FROM THE*C*IPASSES, PLOT IT,AND GO TO NEXT FREQUENCY*E
   6  BR  RET*E
FREQ*E
   1  DE  2+/30*E
   2  DT  3,0+/25,3+/40,0+/(FREQUENCY SEQUENCE )-*C*I*I  (T)HE SEQUENCE IS WHICH FREQUENCIES ARE*C*ITESTED IS(6*C*I*I)10
          00*C*I2000*C*I4000*C*I8000*C*I(9)RETEST 1000 FOR FIRST EAR ONLY(0*C*I)500*C*I250*C*I125*E
RET*E
   1  DT  30,0+/2,30+/40,0+/(P)RESS SPACE BAR TO RETURN TO INDEX.*E
   2  EPI 30,39+/2,30+/1,37+/+/1+/*E
   3  AA  (8+/)ZZ*E
   4  BR  REVIEW*E
INTRO*E
SS 1  NO  COMMENT-  THIS IS AN INTRODUCTORY SEQUENCE TO THIS UNIT.  THE NEED FOR PAUSES OF LIMITED DURATION IS INTRODUCE
          D, AND MECHANICS FOR STUDENT CONTROL OF THIS UNIT ARE DISCUSSED.*E
   2  PRR *E
   3  LD  0+/S0*E
   4  FN  SF+/5+/S0+/S30*E
   5  LD  0+/C1*E
   6  FN  SF+/4+/C1+/C30*E
   7  FN  CH+/K*E
   8  DE  0+/32*E
   9  DT  0,0+/9,0+/40,0+/  (T)HIS TIME YOU WILL TEST THE LEFT EAR*C*IOF THE SAME SUBJECT.*C*I*I  (Y)OU WILL BE GIVING T
          HRESHOLD TESTS*E
  10  DT  7,0+/6,7+/40,0+/WITH LITTLE ASSISTANCE - THERE WILL BE*C*INO INSTRUCTIONS CONCERNING THE FREQUENCY*C*IOR HEARI
          NG LEVEL AND NO TABLE OF*E
  11  DT  13,0+/6,13+/40,0+/RESPONSES.  (Y)OU WILL BE ON YOUR OWN,*C*IJUST AS IF YOU WERE TESTING A REAL*C*ISUBJECT, ALT
          HOUGH (I )MAY POINT OUT ERRORS*E
  12  DT  19,0+/10,19+/40,0+/IF YOU MAKE THEM.*C*I*I  (W)HEN YOU FINISH, (I)'LL TELL YOU HOW*C*IYOU DID.*E
  13  DT  29,0+/2,29+/40,0+/(P)RESS SPACE BAR WHEN READY TO CONTINUE.*E
  14  EPI 30,39+/2,30+/1,38+/+/1+/INTROMOD1*E
  15  NX  *E
  16  DTI 29,20+/3,29+/20,20+/*I+P+R+E+S+S +W+H+E+N +R+E+A+D+Y*E
  17  BR  RE*E
  18  AA  (8+/)START4+/AA*E
  19  BR  INTRO1*E
INTRO1*E
   1  PR  *E
   2  DE  0+/32*E
   3  DT  0,0+/6,0+/40,0+/  (B)ECAUSE YOU'LL BE ON YOUR OWN, IT IS*C*IIMPORTANT TO CONSIDER THE LENGTH OF THE*C*IPAUSE B
          ETWEEN TONES.*E
   4  DT  9,0+/6,9+/40,0+/  (G)OOD AUDIOMETRIC PRACTICE CALLS FOR A*C*IPAUSE OF 2 TO 4 SECONDS BETWEEN TONE*C*IPRESENTAT
          IONS.*E
   5  DT  18,0+/6,18+/40,0+/  (A)S YOU DID WITH THE TONE DURATION, YOU*C*ISHOULD VARY THE PAUSE LENGTHS.  (T)HUS,*C*ITHE
           DURATION OF EITHER TONE OR*B*B(-- )PAUSE*E
   6  DT  24,0+/6,24+/40,0+/SHOULD VARY BETWEEN    AND    SECONDS.*C*I(9T)YPE AND ENTER ANSWERS(0*E
   7  PR  *E
   8  ECI 24,20+/2,24+/2,20+/+/2*E
   9  EPI 24,27+/2,24+/2,27+/300+/2+/INTRO1*E
  10  NX  *E
  11  DT  30,0+/2,30+/40,0+/(R)EAD PROBLEM AND TYPE ANSWER.*E
  12  BR  PRO*E
  13  CA  2+/4+/CA*E
  14  DTI 28,0+/4,28+/40,0+/*I*I        (RIGHT*E
  15  PA  30*E
  16  UN  U1*E
  17  DT  28,0+/4,28+/40,0+/(N)O.  (R)EAD AGAIN AND TRY AGAIN. (9Y)OU MAY*C*IHAVE ENTERED THE FIRST ANSWER - DON'T(O*E
  18  BR  PRO*E
  19  UN  U2*E
  20  DT  28,0+/4,28+/40,0+/(S)TILL NO.*E
  21  PA  30*E
  22  BR  INTRO2*E
INTRO2*E
   1  PR  *E
   2  FN  CH+/K*E
   3  DE  0+/32*E
   4  LD  0+/S2*E
   5  DT  0,0+/6,0+/40,0+/  (Y)OU VARY BOTH TONE DURATION AND PAUSES*C*IBETWEEN 2 AND 4 SECONDS SO AS TO GIVE*C*ITHE SUB
          JECT TIME TO RESPOND AND ALSO*E
   6  DT  6,0+/6,6+/40,0+/TIME TO REST BETWEEN TONES, AND TO ALLOW*C*IYOU TO MOVE THROUGH THE HEARING TEST*C*IRAPIDLY A
          D EFFICIENTLY.*E
INT2A*E
   1  DT  13,0+/6,13+/40,0+/  (T)HE DURATION OF YOUR TONES AND PAUSES*C*IWILL BE TIMED.  (Y)OU MAY HAVE DISPLAYED*C*ITHE
           DURATION OF EACH.*C*I*IIF YOU WANT THIS IN*E
   2  DT  20,0+/6,20+/40,0+/  (I)F YOU WANT IT DISPLAYED,PRESS HERE-+,*B,*E
   3  DT  23,0+/2,23+/40,0+/  (I)F YOU DON'T WANT IT, PRESS HERE - +,*B,*E
   4  EPP 600+/INTRO2*E
   5  NX  *E
   6  DTI 30,0+/2,30+/40,0+/(P)RESS LIGHT PEN AGAINST A LIGHTED SQUARE*E
   7  BR  RE*E
   8  CAP 2,20,4,37+/DI*E
   9  LD  1+/S1*E
  10  BR  CHOIS1+/S2+/1*E
  11  CAP 2,23,4,36+/NO*E
  12  LD  0+/S1*E
  13  BR  CHOIS1+/S2+/1*E
  14  UN  UU*E
  15  DT  30,0+/2,30+/40,0+/(P)RESS LIGHT PEN TO LIGHTED SQUARE.*E
  16  BR  RE*E
INTRO3*E
   1  PR  *E
   2  DE  0+/32*E
   3  DT  0,0+/6,0+/40,0+/  (W)HEN YOU ARE COMPLETELY FINISHED*C*ITESTING, WAIT ABOUT 20 SECONDS AND A*C*IMESSAGE WILL A
          PPEAR WHICH ASKS IF YOU*E
   4  DT  6,0+/9,6+/40,0+/ARE FINISHED, AT WHICH TIME YOU CAN SAY*C*ISO.*C*I*I  (S)OMETIMES THIS MESSAGE WILL APPEAR*C*I
          BETWEEN FREQUENCIES, SO JUST INDICATE*E
   5  DT  15,0+/8,15+/40,0+/YOU ARE NOT FINISHED.*C*I*I  (I)F YOU WANT TO CHANGE YOUR MIND ABOUT*C*IHAVING THE DURATIONS
           DISPLAYED, JUST*E
   6  DT  22,0+/8,22+/40,0+/WAIT FOR THE MESSAGE AND INDICATE THAT*C*IYOU WANT TO CHANGE.*C*I*I  (Y)OU CAN DO THE SAME T
          HING TO OBTAIN A*E
   7  DT  29,0+/2,29+/40,0+/REVIEW OF TESTING PROCEDURE. +P+R+E+S+S +S+P+A+C+E*E
   8  EPI 25,39+/2,25+/1,37+/+/1+/*E
   9  AA  (8+/)ZZ*E
INTRO4*E
   1  PR  *E
   2  DE  0+/32*E
   3  DT  10,0+/6,10+/40,0+/(H)ERE IS WHAT THE MESSAGE WILL LOOK LIKE.*C*I(T)HE MESSAGE IS ON THE LEFT SIDE OF THE*C*ISC
          REEN, AND THE EXPLANATION OF EACH*E
   4  DT  16,0+/6,16+/40,0+/CHOICE IS ON THE RIGHT.*E
   5  PA  80*E
   6  DE  0+/32*E .
   7  DT  0,0+/4,0+/40,0+/(I)F NOT FINISHED  (P)RESS TO CONTINUE TEST-*C*I (P)RESS HERE - +,*B, *R-*IING SAVE OR NEXT FR
          EQ.*E
   8  PA   50*E
   9  DT   5,0+/6,5+/40,0+/(T)O START OVER    *I(P)RESS TO START AGAIN*C COMPLETELY      *IFROM THE BEGINNING.*C (P)RESS
           HERE - +,*B,*E
  10  PA   60*E
  11  DT   12,0+/6,12+/40,0+/(W)HEN COMPLETELY  (P)RESS IF ALL FINISHED*C*I FINISHED,      -WITH AUDIOGRAM FOR*C*I (P)RES
           S HERE - +,*B,  THIS EAR.*E
  12  PA   60*E
  13  DT   19,0+/6,19+/40,0+/(T)O CHANGE INFO   (P)RESS TO START OR STOP*C*IDISPLAY,PRESS +,*B, *R-*IDURATION INFORMATION
           .*E
  14  PA   50*E
  15  DT   25,0+/4,25+/40,0+/(F)OR REVIEW,      (P)RESS FOR REVIEW OF*C*I (P)RESS HERE - +,*B, *R-*ITESTING PROCEDURE.*E
  16  PA   30*E
  17  DT   30,0+/2,30+/40,0+/(P)RESS +N+O+T +F+I+N+I+S+H+E+D (SQUARE )TO CONTINUE*E
  18  EPP +/INTRO4*E
  19  AAP 32,0,40,0+/AA*E
INTRO5*E
   1  PR   *E
   2  DE   0+/32*E
   3  DT   2,0+/8,2+/40,0+/  (B)E SURE TO FILL IN YOUR AUDIOGRAM*C*IAFTER YOU FIND THE THRESHOLD FOR EACH*C*IFREQUENCY.
           (R)EMEMBER THAT YOU MARK THE*E
   4  DT   8,0+/4,8+/40,0+/THRESHOLDS WITH A BLUE (X 9)LIKE YOU USED*C*IA RED CIRCLE FOR THE RIGHT EAR(0).*E
   5  DT   12,0+/8,12+/40,0+/  (S)ET THE PANEL TO START TESTING THE*C*ILEFT EAR OF YOUR SUBJECT.  (B)ASED ON THE*C*IRESUL
           TS OF THE RIGHT EAR, YOU SHOULD*E
   6  DT   18,0+/8,18+/40,0+/ASSUME NORMAL HEARING.*C*I*I  (B)E SURE TO START WITH 1000 (H)Z.*C*I*I*E
   7  DT   24,0+/6,24+/40,0+/  (B)E SURE TO REMEMBER THE HEARING LEVEL*C*IOF THE LOWEST (YES )RESPONSE FOR EACH*C*IPASS.
            (T)HESE ARE THE ONLY NUMBERS YOU*E
   8  DT   30,0+/2,30+/40,0+/NEED TO REMEMBER.  (PRESS SPACE TO START *E
   9  EPI 18,39+/2,18+/1,37+/+/1+/*E
  10  AA   (8+/)ZZ*E
ONEL*E
   1  PR   *E
   2  LD   1+/S2*E
   3  DE   0+/32*E
   4  DTI 0,0+/20,0+/10,0+/(T)EST THE*C*ILEFT EAR*C*IOF YOUR*C*ISUBJECT.*C*I*I(B)E SURE TO*C*ISTART WITH*C*I1000 (HZ).*E
   5  PA   30*E
   6  FN   CH+/A*E
   7  LR   1A+/RR5*E
   8  BR   HON*E
WAIST*E
   1  EP   ,0+/2,+/40,0+/50+/1+/+/*E
   2  AA   (8+/)ZZ*E
   3  PA   10*E
   4  EPP 0+/*E
   5  PR   *E
   6  DTI 0,0+/30,0+/10,0+/*I*I*I*I*I*I*I*I(G)IVE*C*ITONE*C*IAGAIN.*E
IA*E
$$ 1  NC   COMMENT-  THIS IS THE BEGINNING OF THE LOOP USED FOR TESTING.  THIS IS THE POINT WHERE THE PROGRAM EXPECTS THE
            DEPRESSION OF THE TONE.*E
   2  LD   0+/S30*E
   3  FN   CH+/A*E
   4  AD   1+/C1*E
   5  LR   1A+/RR4*E
   6  FN   SF+/3+/C20*E
   7  EP   ,0+/2,+/40,0+/200+/8+/1A+/*E
   8  LD   C0+/C21*E
   9  LD   B0+/B1*E
  10  NX   *E
  11  BR   CHOICE*E
  12  CA   1(888)0010+/C1*E
  13  BR   HL*E
  14  AA   (8+/)A1*E
  15  DTI 0,0+/20,0+/10,0+/  (ERROR*C*I)ON (TONE*C*INORM),(SISI),*C*I  (TONE*C*I WARBLE),*C*IOR (C)H. 2*C*IDIALS.*C*I*I
```

```
          C)ORRECT,*C*IGIVE TONE*C*IAGAIN,*E
  16  AD  1+/C9*E
  17  BR  WAIST*E
CHOICE*E
SS 1  NO  COMMENT-  IF THE STUDENT WAITS 20 SECONDS AFTER RELEASING THE TONE SWITCH, THIS SELECTION IS DISPLAYED WHICH A
          LLOWS HIM TO OBTAIN REVIEW MATERIAL, START OVER, CHANGE THE INFORMATION DISPLAYED DURING TESTING, KEEP GOING,
          OR TELL THE PROGRAM HE H*E
SS 2  NO  HAS FINISHED TESTING AND IS READY TO SUBMIT HIS RESULTS.*E
   3  DTI 0,0+/3,0+/15,0+/(P)AUSE TOO LONG.*E
   4  DTI 3,0+/25,3+/15,0+/(I)F NOT FINISHED*C*I (P)RESS HERE - +,*B,*C*I*I(T)O START OVER*C*I COMPLETELY*C*R (---------
          -*C*I P)RESS HERE - +,*B,*C*I*I(W)HEN COMPLETELY*C*I FINISHED,*C*I (P)RESS HERE - +,*B,*C*I*I(T)O CHANGE INFO*
          C*I DISPLAY,(P)RESS+,*B,*C*I*I(F)OR REVIEW,*C*I (P)RESS HERE - +,*B,*E
   5  DTI 27,0+/4,27+/15,0+/(F)OR REVIEW,*C*I (P)RESS HERE - +,*B,*E
   6  EPP 300+/CHOICE*E
   7  NX  *E
   8  DTI 30,20+/2,30+/10,20+/ +P+R+E+S+S*E
   9  BR  RE*E
  10  CAP 4,19,3,13+/FN*E
  11  DE  0+/32*E
  12  BR  DONE*E
  13  CAP 4,4,3,13+/NF*E
CHOIS1*E
   1  DE  0+/32*E
   2  DTI 0,0+/32,0+/15,0+/*C*I*I(I)'M READY,*C*I*I  (G)IVE*C*I   THE*C*I    TONE,*E
   3  DE  30+/2*E
   4  PA  20*E
   5  BR  HDN*E
   6  CAP 4,12,3,13+/RE*E
   7  DE  0+/32*E
   8  LD  0+/C17*E
   9  BR  INTRO2*E
  10  CAP 4,23,3,13+/DI*E
  11  DE  0+/32*E
  12  BR  INT2A*E
  13  CAP 4,28,3,13+/RE*E
  14  BR  REVIEW*E
  15  UN  UU*E
  16  DTI 28,0+/4,28+/11,0+/  +P+R+E+S+S*C*I  +A+G+A+I+N*E
  17  BR  RE*E
  18  EA  *E
HL*E
SS 1  NO  COMMENT-  THE FOLLOWING CODING PROCESSES THE STUDENT'S RESPONSE, DETERMINES IF IT IS ABOVE OR BELOW THE PREDET
          ERMINED THRESHOLD, COMPARES IT WITH THE PREVIOUS INPUT TO DETERMINE IF IT IS AN ACCEPTABLE OPTION, AND PROVIDE
          S FEEDBACK AS NECESSARY.*E
   2  PR  *E
   3  LD  B1+/B0*E
   4  LD  0+/S10*E
   5  BR  HLTEST*E
HLTEST*E
   1  LD   +/B2*E
   2  FN  MV+/B1,1,1+/B2+/IA*E
   3  FN  SF+/2+/FR+/B2+/C1+/C12*E
   4  BR  ADJ1+/C12+/L+/16624*E
   5  SB  16624+/C12*E
   6  BR  CONV*E
ADJ1*E
   1  BR  ADJ2+/C12+/L+/16529*E
   2  SB  16510+/C12*E
   3  BR  CONV*E
ADJ2*E
   1  SB  16503+/C12*E
CONV*E
```

```
   1  MP  5+/C12*E
   2  SB  10+/C12*E
OUTCK*E
   1  PR  *E
   2  CA  1(88)2(8+/)LE*E
   3  WA  1(88)1(8+/)RT*E
   4  WB  1(88)0(8+/)BN*E
   5  DTI 0,0+/32,0+/10,0+/(Y)OUR (C)H,1*C*I(OUTPUT*C*I)SHOULD*C*IBE ON*C*I(LEFT),*E
   6  BR  WAIST*E
   7  UN  UU*E
   8  DTI 0,0+/32,0+/10,0+/(SYSTEM*C*IERROR),*C*I*I(Y)OU MAY*C*IHAVE GIVEN*C*IYOUR TONES*C*ITOO CLOSE*C*ITOGETHER,*C*I*I
          (G)IVE TONE*C*IAGAIN,*E
   9  BR  WAIST*E
LEFT*E
   1  PR  *E
   2  LD  L       +/B3*E
   3  FN  MV+/B1,2,1+/B3,1+/*E
   4  FN  SF+/6+/B3+/RR2*E
   5  BR  RR2*E
L1*E
   1  LD  125+/C16*E
   2  LD  0+/C26*E
   3  LD  -5+/C27*E
   4  LD  -5+/C28*E
   5  LD  5+/C30*E
   6  BR  ANAL*E
L2*E
   1  LD  250+/C16*E
   2  LD  -10+/C26*E
   3  LD  -5+/C27*E
   4  LD  -10+/C28*E
   5  BR  ANAL*E
L3*E
   1  LD  500+/C16*E
   2  LD  -5+/C26*E
   3  LD  5+/C27*E
   4  LD  -10+/C28*E
   5  LD  15+/C30*E
   6  BR  ANAL*E
L5*E
   1  LD  1000+/C16*E
   2  LD  5+/C26*E
   3  LD  10+/C27*E
   4  LD  0+/C28*E
   5  BR  ANAL*E
L7*E
   1  LD  2000+/C16*E
   2  LD  20+/C26*E
   3  LD  20+/C27*E
   4  LD  20+/C28*E
   5  BR  ANAL*E
L9*E
   1  LD  4000+/C16*E
   2  LD  40+/C26*E
   3  LD  35+/C27*E
   4  LD  40+/C28*E
   5  BR  ANAL*E
L8*E
   1  LD  8000+/C16*E
   2  LD  75+/C26*E
   3  LD  75+/C27*E
   4  LD  75+/C28*E
```

```
    5  BR   ANAL*E
    6  UN   UU*E
    7  DTI  0.0+/30.0+/10.0+/(Y)OU USED*C*IAN*C*IINCORRECT*C*IFREQUENCY.*C*I*I(C)ORRECT*C*IAND GIVE*C*ITONE*C*IAGAIN.*E
    8  AD   1+/C6*E
    9  BR   WAIST*E
ANAL*E
    1  PR   *E
    2  BR   NEW+/C16+/NE+/C17*E
    3  BR   ANAL1+/C12+/NE+/C13*E
    4  AD   1+/C30*E
    5  LR   ERR1M+/RR4*E
ANAL1*E
    1  BR   TWO+/C19+/E+/2*E
    2  BR   THREE+/C19+/E+/3*E
ONE*E
    1  BR   ATWO+/C12+/G+/C13*E
ONEA*E
    1  BR   HUP+/C12+/GE+/C26*E
    2  AD   1+/C18*E
    3  BR   PAUSE+/C18+/L+/3*E
    4  AD   1+/C10*E
    5  LR   ERR2M+/RR4*E
    6  BR   PAUSE*E
ATWO*E
    1  LD   2+/C19*E
    2  LD   0+/C18*E
TWO*E
    1  BR   ATHREE+/C12+/L+/C13*E
    2  BR   TWOA+/C12+/GE+/C27*E
    3  BR   PAUSE*E
TWOA*E
    1  AD   1+/C18*E
    2  BR   HUP+/C18+/L+/3*E
    3  LD   C12+/C11*E
    4  SR   C13+/C11*E
    5  BR   HUP+/C11+/G+/5*E
    6  AD   1+/C10*E
    7  LR   ERR3M+/RR4*E
    8  BR   HUP*E
ATHREE*E
    1  LD   0+/C18*E
    2  LD   3+/C19*E
THREE*E
    1  BR   HUP+/C12+/GE+/C28*E
    2  AD   1+/C18*E
    3  BR   PAUSE+/C18+/L+/3*E
    4  AD   1+/C10*E
    5  DTI  0.0+/32.0+/10.0+/(Y)OU SHOULD*C*IHAVE BEEN*C*IFINISHED*C*IWITH THIS*C*IFREQUENCY.*C*I*I(P)LOT THE*C*ITHRESHOLD
            *C*ION YOUR*C*IAUDIOGRAM*C*IAND GO ON*C*ITO NEXT*C*IFREQUENCY.*E
    6  BR   PAUSE*E
NEW*E
    1  LD   C16+/C17*E
    2  LD   0+/C18*E
    3  LD   1+/C19*E
    4  BR   HYCK+/C16+/GE+/4000*E
    5  BR   ONEA*E
HYCK*E
    1  BR   HYCK1+/S3+/1*E
    2  BR   HUP+/C12+/GE+/C26*E
    3  LD   1+/S3*E
    4  LD   9999+/C17*E
    5  BR   PAUSE*E
```

```
HYCK1*E
   1  LD  9999+/C17*E
   2  BR  GOOD3+/C12+/G+/C13*E
   3  BR  ERR1M+/C12+/E+/C13*E
   4  AD  1+/C10*E
   5  LD  1+/S5*E
   6  DTI 0,0+/32,0+/14,0+/(W)HY GO DOWN(/*C*I*IW)HEN YOU START*C*IBELOW THRES-*C*IHOLD, YOU GO*C*IUP IN 10 DB*C*ISTEPS
          UNTIL*C*IYOU GET A*C*I(YES )RESPONSE.*C*I*I(T)HEN START THE*C*IFIRST DESCEND-*C*IING PASS 30 DB*C*IABOVE THAT*
          C*ILEVEL.*E
   7  EP  ,0+/2,+/40,0+/100+/10+/+/*E
   8  PR  *E
   9  BR  1A*E
GOOD3*E
   1  BR  GOOD3A+/S4+/1*E
   2  BR  GOOD3C+/S5+/1*E
   3  LR  GOOD4+/RR4*E
   4  LD  1+/S4*E
   5  BR  ONEA*E
GOOD3A*E
   1  BR  GOOD3B+/C12+/GE+/C26*E
   2  BR  PAUSE*E
GOOD3B*E
   1  LD  0+/S3*E
   2  LD  0+/S4*E
   3  BR  HUP*E
GOOD3C*E
   1  LR  BLANK+/RR4*E
   2  LD  0+/S5*E
   3  BR  ONEA*E
HUP*E
   1  DTI 5,11+/28,0+/20,0+/*1(-)'*B(L6*B*B*B*I*I)' '*B*I*I5*B*B*B+O*ITT*B*B*I+I+J*B*B*I*IZ*B*R10T*I*IT*I*IT9*B*R*RI6*B*
          R*R3*R*R)S*RX*B*B*B*B*B*B*B*B*I*I*I*I*IT*I*IT*I*IT*I*IT*I*IMA*RSF*B*R*RF*B*R*RF*I*I*I*I*I*I*B*B*B*B*B*B*B+K+-E
          EEEEE*E
   2  DE  28+/2*E
PAUSE*E
   1  AD  C22+/C24*E
   2  LD  C20+/C22*E
   3  AD  C21+/C22*E
   4  SB  C24+/C22*E
   5  BR  PAUSE1+/S1+/0*E
   6  FN  MV+/C22+/+/B4+/*E
   7  FN  MV+/'.'+/B4,4+/IA*E
   8  FN  MV+/B4,3,4+/B4,0+/*E
   9  DTI 30,12+/2,30+/32,12+/(PAUSE DURATION        SEC).*E
  10  DTI 30,28+/2,30+/4,28+/B4*E
PAUSE1*E
   1  BR  POVER+/C22+/G+/45*E
   2  BR  PUNDER+/C22+/L+/20*E
   3  BR  RESP*E
POVER*E
   1  AD  1+/C5*E
   2  BR  RESP*E
PUNDER*E
   1  AD  1+/C7*E
RESP*E
   1  FN  SF+/3+/C23*E
   2  LD  C23+/C24*E
   3  EP  ,0+/2,+/40,0+/60+/1+/RESP+/*E
   4  NX  *E
   5  BR  RESPN*E
   6  AA  (8+/)ZZ*E
   7  LD  C12+/C13*E
   8  AD  1+/C4*E
   9  LD  C0+/C22*E
  10  LR  RESP1+/RR5*E
  11  BR  RESP1+/S30+/1*E
HDN*E
   1  DTI 0,20+/9,0+/15,11+/*1*I*I*I F*B(1*B*R+T*B*I*I3 *R1*B*R+T*B*I*0).*178*B*I*IF*B*I*IF*B*B*B*B*B*R*RF*B*IF*B*IUVW*B
          *B*B*IMN+F+G*B*B*B*R*R*R*B+V+U*B1*B*B*R*R*R*R(-)E(ST*B*B)E(/*B*B*B)L*BK*B*E
   2  DTI 9,17+/6,9+/19,11+/*1*I*I*I*I*I(&*B*R*R3*R*R)S*RXYFOJ(3*B*B*B*B*R)MN+F+GR*B*I*I(3*R+S+T*I)R*I*I+2*B*I*I'*B*B*B*
          RF*B*B*B*B*B*B*BT+E*I=*B*R*R'*B*B*B+J*B+0*B*R*RFLM*B*B*I+0*B+I+E*R+J*B (&+U*B*I+M*B*I)S*B*B9*B*R*R*R*E
   3  DTI 15,16+/6,15+/20,11+/*1*I*I*I*I*I(&*B*R*R3*R*R)9*B*R*R(& *I*I*I)F*B*I*IF  *R+E*B*R*R+E*B*R+E(3)S*B*B*I*I(&*B*I*
          I)9   =U F*B*RF*B*B*B*B*R'*B*R*R+2 *R'*B*I*I=*B*B*B*B*BE+0*E
   4  DTI 23,10+/5,21+/24,10+/*1 *I*I+I+J*B*R*R+K+LEE+0*B*R*R*R(&*B*I*I)I*B*I*II*B+K*IC*R+N*B(&*B*R*R3*R*R)F*B*I*I*IEE*R
          +K*B+N*B*B*I(3*B*I*I+0+A*R+I+J*B*B*R*R+AT*B*I*IU)UVWXY*R*RO*I+0*B+0+P*B*B*B*B*B*B*B*B*E*R*RUVWXY*R  F*E
   5  DTI 26,10+/4,26+/10,10+/*1*I+L*R*R+I+J   *I(3*B*I*I)=*I+A+A*B*RT*B*R+A*B*RT*E
   6  BR  RR5*E
RESP1*E
   1  SB  C20+/C23*E
   2  AD  C22+/C23*E
   3  SB  C21+/C23*E
   4  BR  RESP2+/S1+/0*E
   5  FN  MV+/C23+/+/B4+/*E
   6  FN  MV+/'.'+/B4,4+/IA*E
   7  FN  MV+/B4,3,4+/B4,0+/*E
   8  DTI 30,12+/2,30+/28,12+/     TONE DURATION       SEC.*E
   9  DTI 30,30+/2,30+/4,30+/B4*E
RESP2*E
   1  BR  OVER+/C23+/G+/40*E
   2  BR  UNDER+/C23+/L+/20*E
   3  BR  RR4*E
OVER*E
   1  AD  1+/C2*E
   2  BR  RR4*E
UNDER*E
   1  AD  1+/C3*E
   2  BR  RR4*E
RESPN*E
   1  AD  1+/C3*E
   2  BR  RESPB+/S30+/1*E
   3  DTI 0,0+/30,0+/11,0+/(PANEL COR)-*C*I(RECT), (BUT*C*ITONE TOO*C*ISHORT).*C*I*I(GIVE IT*C*IAGAIN).*C*I*I*I(DISREGAR
          D*C*I PATIENT*C*IRESPONSE).*E
   4  LR  RESPA+/RR5*E
   5  BR  HDN*E
RESPA*E
   1  BR  RR4*E
RESPB*E
   1  DTI 0,0+/30,0+/11,0+/ (PANEL*C*ICORRECT),*C*I(BUT TONE*C*ITOO LONG).*C*I*I(SUBJECT*C*IMAY NOT*C*IWANT TO*C*IRESPON
          D).*E
   2  BR  RR4*E
GOOD4*E
   1  DTI 0,0+/32,0+/14,0+/(G)OOD. (Y)OU SAW*C*ITHAT YOU HAVE*C*ITO START UP.*C*I*I(I)F YOU*C*ISTARTED BELOW*C*ITHRESHOL
          D,*C*IINCREASE BY*C*I10 DB STEPS*C*IUNTIL YOU GET*C*IA RESPONSE.*C*I*I(S)TART THE*C*IDESCENDING*C*IPASS 30 DB*
          C*IABOVE THAT*C*IPOINT.*E
   2  EP  ,0+/2,+/40,0+/100+/10+/+/*E
   3  PR  *E
   4  BR  1A*E
ERR1V*E
   1  DTI 0,0+/32,0+/14,0+/(Y)OU SHOULDN'T*C*IGIVE THE SAME*C*IHEARING LEVEL*C*ITWO TIMES IN*C*IA ROW.*C*I*I(I)F YOU'RE*
          C*IHAVING TROUBLE*C*IWAIT FOR THE*C*IMESSAGE AND*C*IUSE THE*C*IREVIEW.*E
   2  EP  ,0+/2,+/40,0+/50+/10+/+/*E
   3  PR  *E
   4  BR  1A*E
ERR2V*E
```

```
   1  DTI 0,0+/32,0+/14,0+/(Y)OU SHOULD*C*ISTART THE*C*IASCENDING*C*IPASS AFTER*C*I2 CONSECUTIVE*C*I(NO )RESPONSES,*C*IS
          INCE YOU*C*IKNOW YOU ARE*C*IBELOW SUBJECTS*C*ITHRESHOLD,*C*I*IREMEMBER THE*C*ILOWEST (YES*C*I)RESPONSE,*E
   2  EP  ,0+/2,+/40,0+/50+/10+/+/*E
   3  PR  *E
   4  BR  1A*E
ERR3V*E
   1  DTI 0,0+/32,0+/14,0+/(A)FTER 2 (YES*C*I)RESPONSES YOU*C*IKNOW YOU ARE*C*IABOVE THE*C*ITHRESHOLD,*C*I*I(N)OW INCREA
          SE*C*IBY 30 DB OVER*C*IHIGHER OF THE*C*I2 ESTIMATES*C*IAND START LAST*C*IDESCENDING*C*IPASS,*C*I*I(R)EMEMBER A
          LL*C*ITHRESHOLDS,*E
   2  EP  ,0+/2,+/40,0+/50+/10+/+/*E
   3  PR  *E
   4  BR  1A*E
BLANK*E
   1  DTI 0,0+/32,0+/14,0+/*E
   2  BR  1A*E
DONE*E
SS 1  NO  COMMENT-  AFTER THE STUDENT IS FINISHED TESTING THE EAR, HE IS BRANCHED HERE WHERE HE CAN SUBMIT HIS RESULTS A
          ND RECEIVE FEEDBACK,*E
   2  PR  *E
   3  FN  CH+/K*E
   4  DE  0+/32*E
   5  DTI 0,0+/8,0+/40,0+/  (A)FTER YOU TELL ME WHAT YOU GOT FOR*C*IYOUR AUDIOGRAM (I)'LL TELL YOU HOW YOU DID*C*ION THI
          S EAR,*E
   6  DT  7,0+/4,7+/40,0+/  (T)YPE (9)AND ENTER(0 )THE THRESHOLDS YOU*C*IFOUND FOR EACH FREQUENCY, ONE AT A TIME(&*E
   7  DT  12,0+/20,12+/40,0+/125 (H)Z*C*I*I250 (H)Z*C*I*I500 (H)Z*C*I*I1000 (H)Z*C*I*I2000 (H)Z*C*I*I4000 (H)Z*C*I*I8000
           (H)Z*E
   8  EPI 12,10+/2,12+/30,10+/800+/4+/DONE*E
   9  FN  ED+/+/,D+/+/ *E
  10  NX  *E
  11  DTI 15,10+/2,15+/30,10+/(T)YPE AND ENTER THRESHOLD,*E
  12  BR  RE*E
  13  CA  -5+/12*E
  14  CB  -5DB+/12*E
  15  DTI 12,20+/2,12+/20,20+/(RIGHT*E
  16  AA  (8+/)12*E
  17  DTI 12,20+/2,12+/20,20+/(N)O6 SHOULD BE -5 D(B),*E
DONE1*E
   1  PR  *E
   2  EPI 15,10+/2,15+/30,10+/200+/5+/DONE1*E
   3  FN  ED+/+/,D+/+/ *E
   4  NX  *E
   5  DTI 18,10+/2,18+/30,10+/(T)YPE AND ENTER THRESHOLD,*E
   6  BR  RE*E
   7  CA  -10+/25*E
   8  CB  -10DB+/25*E
   9  DTI 15,20+/2,15+/20,20+/(RIGHT*E
  10  AA  (8+/)25*E
  11  DTI 15,20+/2,15+/20,20+/(N)O6 SHOULD BE -10 D(B),*E
DONE2*E
   1  PR  *E
   2  EPI 18,10+/2,18+/30,10+/200+/5+/DONE2*E
   3  FN  ED+/+/,D+/+/ *E
   4  NX  *E
   5  DTI 21,10+/2,21+/30,10+/(T)YPE AND ENTER THRESHOLD,*E
   6  BR  RE*E
   7  CA  -5+/50*E
   8  CB  -5DB+/50*E
   9  DTI 18,20+/2,18+/20,20+/(RIGHT*E
  10  AA  (8+/)50*E
  11  DTI 18,20+/2,18+/20,20+/(N)O6 SHOULD BE -5 DB,*E
DONE3*E
   1  PR  *E
   2  EPI 21,10+/2,21+/30,10+/200+/5+/DONE3*E
   3  FN  ED+/+/,D+/+/ *E
   4  NX  *E
   5  DTI 24,10+/2,24+/30,10+/(T)YPE AND ENTER THRESHOLD.*E
   6  BR  RE*E
   7  CA  5+/10*E
   8  CB  5DB+/10*E
   9  DTI 21,20+/2,21+/20,20+/(RIGHT*E
  10  AA  (8+/)10*E
  11  DTI 21,20+/2,21+/20,20+/(N)O6 SHUULD BE 5 DB.*E
DONE4*E
   1  PR  *E
   2  EPI 24,10+/2,24+/30,10+/200+/5+/DONE4*E
   3  FN  ED+/+/,D+/+/ *E
   4  NX  *E
   5  DTI 27,10+/2,27+/30,10+/(T)YPE AND ENTER THRESHOLD.*E
   6  BR  RE*E
   7  CA  20+/20*E
   8  CB  20DB+/20*E
   9  DTI 24,20+/2,24+/20,20+/(RIGHT*E
  10  AA  (8+/)20*E
  11  DTI 24,20+/2,24+/20,20+/(N)O6 SHOULD BE 20 DB.*E
DONE5*E
   1  PR  *E
   2  EPI 27,10+/2,27+/30,10+/200+/5+/DONE5*E
   3  FN  ED+/+/,D+/+/ *E
   4  NX  *E
   5  DTI 30,10+/2,30+/30,10+/(T)YPE AND ENTER THRESHOLD.*E
   6  BR  RE*E
   7  CA  40+/40*E
   8  CB  40DB+/40*E
   9  DTI 27,20+/2,27+/20,20+/(RIGHT*E
  10  AA  (8+/)40*E
  11  DTI 27,20+/2,27+/20,20+/(N)O6 SHOULD BE 40 DB.*E
DONE6*E
   1  PR  *E
   2  EPI 30,10+/2,30+/30,10+/200+/5+/DONE6*E
   3  FN  ED+/+/,D+/+/ *E
   4  NX  *E
   5  DTI 30,16+/2,30+/24,16+/(T)YPE AND ENTER THRESHOLD.*E
   6  BR  RE*E
   7  CA  75+/80*E
   8  CB  75DB+/80*E
   9  DTI 30,20+/2,30+/24,16+/(RIGHT*E
  10  PA  30*E
  11  AA  (9+/)80*E
  12  DTI 30,20+/2,30+/24,16+/(N)O6 SHOULD BE 75 DB.*E
  13  PA  30*E
GRAY*E
   1  PR  *E
   2  LD  0+/C24*E
   3  DE  0+/32*E
   4  DT  0,0+/8,0+/40,0+/  (T)HIS IS HOW YOUR AUDIOGRAM FOR THE*C*ILEFT EAR SHOULD LOOK.*C*I  (Y)OU'LL BE ABLE TO CHECK
          YOUR WHOLE*C*IAUDIOGRAM IN A MOMENT.*E
   5  DTI 9,24+/2,9+/12,24+/(FREQUENCY HZ*E
   6  DTI 11,19+/1,11+/21,19+/*2*R1*I(2*B*R)5 (2*I)5*B*R(0 )5*I(0*B*RO )1*I(0*B*RO*IO*R2*IO*B*RO*IO*R4*IO*B*RO*IO*R8*IO*
          B*RO*I*20*E
   7  DTI 12,19+/1,12+/21,19+/*1AAAAAAAAAAAAAAAAAAAAAA*E
   8  DTI 13,19+/1,13+/21,19+/*1FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B+E*E
   9  DTI 14,17+/1,14+/23,17+/*1(C*2)1*B*R(0*I*1)FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B+E*B*B*B*B*B*B*B*B*B*B*
          B*B*B*B*B*B*B*B*B*B*BCCCCCCCCCCCCCCCCCCCCC*E
  10  DTI 15,18+/2,15+/22,18+/*20*1FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B+E*B*B*B*B*B*B*B*B*B*B*B*B*B*B*B*B*
```

```
        B*B*B*B+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A*E
   11  DTI 17,18+/1,17+/22,18+/*21*B*R(0*I*1)FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B+E*B*B*B*B*B*B*B*B*B*B*B*B*B*B
        *B*B*B*B*B*B*B*BCCCCCCCCCCCCCTCCCCCCCC*E
   12  DTI 18,18+/2,18+/22,18+/*2(0*1)FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B+E*B*B*B*B*B*B*B*B*B*B*B*B*B*B*B*
        B*B*B*B*B+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A*E
   13  DTI 20,18+/1,20+/22,18+/*23*B*R(0*I*1)FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B+E*B*B*B*B*B*B*B*B*B*B*B*B*B*B
        *B*B*B*B*B*B*B*BCCCCCCCCCCCCCCCCCCCCCC*E
   14  DTI 21,15+/2,21+/25,15+/(DB *2)0*1FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B+E*B*B*B*B*B*B*B*B*B*B*B*B*B*B
        *B*B*B*B*B*B+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A*E
   15  DTI 23,18+/1,23+/22,18+/*25*B*R(0*I*1)FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B+E*B*B*B*B*B*B*B*B*B*B*B*B*B*B
        *B*B*B*B*B*B*B*BCCCCCCCCCCCCCCCCCCCCCC*E
   16  DTI 24,18+/2,24+/22,18+/*2(Z*1)FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B+E*B*B*B*B*B*B*B*B*B*B*B*B*B*B*B*
        B*B*B*B*B+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A*E
   17  DTI 26,18+/1,26+/22,18+/*27*B*R(0*I*1)FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B+E*B*B*B*B*B*B*B*B*B*B*B*B*B*B
        *B*B*B*B*B*B*B*BCCCCCCCCCCCCCCCCCCCCCC*E
   18  DTI 27,18+/2,27+/22,18+/*2+X*1FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B+E*B*B*B*B*B*B*B*B*B*B*B*B*B*B*B
        *B*B*B*B+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A*E
   19  DTI 29,18+/1,29+/22,18+/*29*B*R(0*I*1)FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B+E*B*B*B*B*B*B*B*B*B*B*B*B*B*B
        *B*B*B*B*B*B*B*BCCCCCCCCCCCCCCCCCCCCCC*E
   20  DTI 30,17+/2,30+/23,17+/*2+IO*1FI*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B  I*B+B+E*B*B*B*B*B*B*B*B*B*B*B*B*B*B*B*
        B*B*B*B*B+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A+A*E
GRAYCK*E
    1  DTI 15,20+/1,15+/1,20+/*2*R+J*E
    2  DTI 14,23+/1,14+/1,23+/*2+K*E
    3  DTI 15,26+/1,15+/1,26+/*2*R+J*E
    4  DTI 16,29+/1,16+/1,29+/*2+J*E
    5  DTI 18,32+/2,18+/1,32+/*2+H*E
    6  DTI 21,35+/2,21+/1,35+/*2+H*E
    7  DTI 27,38+/1,27+/1,38+/*2*R+J*E
    8  PA  120*E
GRAMFI*E
    1  PR  *E
    2  DT  0,0+/8,0+/40,0+/(C)OMPARE YOUR COMPLETED AUDIOGRAM WITH*C*ITHE SLIDE.  (N)OTE ANY ERRORS AND CONSIDER*C*IHOW T
           HEY MAY HAVE OCCURRED (9)BUT YOU*E
    3  DT  6,0+/2,6+/40,0+/SHOULDN'T HAVE MADE ANY(0).*E
    4  DT  9,0+/4,9+/40,0+/  (D)ID YOU REMEMBER TO USE THE BLUE (X)'S*C*IFOR THE LEFT EAR(/*E
    5  FP1 133*E
    6  FN  CH+/K*E
    7  DTI 8,0+/24,8+/10,0+/*I*I(PRESS THE*C*ISPACE BAR*C*ITO GO ON).*E
    8  EPI 30,0+/2,30+/1,2+/+/1+/PGTRN*E
    9  AA  (8+/)ZZ*E
FIN*E
    1  PR  *E
    2  FPC *E
    3  DE  0+/32*E
    4  DT  0,5+/2,0+/40,0+/(N)OW LET'S LOOK AT HOW YOU DID.*E
    5  LD  C4+/C11*E
    6  MP  100+/C11*E
    7  DV  C1+/C11*E
    8  LD        (T)OTAL NUMBER OF ATTEMPTS          *C*I(3P)ANEL SETTINGS CORRECT     (P)ERCENT    +/B5*E
    9  FN  VV+/C1+/NC+/,31+/*E
   10  FN  MV+/C4+/NC+/,66+/*E
   11  FN  MV+/C11+/NC+/,78+/*E
   12  DT  3,0+/5,3+/40,0+/B5*E
   13  LD  (3 E)RRORS WITH (C)H.1 (F)REQUENCY          *C*I(3 E)RRORS WITH (C)H.1 (H)EARING (L)EVEL       +/B5*E
   14  FN  MV+/C6+/NC+/,36+/*E
   15  FN  MV+/C30+/NC+/,77+/*E
   16  DT  8,0+/4,8+/40,0+/B5*E
   17  LD  (3 E)RRORS WITH (C)H.1 (O)UTPUT            +/B5*E
   18  FN  MV+/C8+/NC+/,36+/*E
   19  DT  12,0+/2,12+/40,0+/B5*E
   20  LD  (3 E)RRORS WITH (SISI), (C)H.2, (T)ONE (N)ORM,   *C*I     AND/OR (T)ONE (W)ARBLE              +/B5*E
```

```
  21  FN  MV+/C9+/NC+/,77+/*E
  22  DT  14,0+/4,14+/40,0+/B5*E
  23  LD  (3 P)ROCEDURE ERRORS (9)EXCESS TESTING(0    *C*I*I3 T)ONES TOO SHORT      (3 )TOO LONG        +/B5*E
  24  FN  MV+/C10+/NC+/,36+/*E
  25  FN  MV+/C3+/NC+/,60+/*E
  26  FN  MV+/C2+/NC+/,78+/*E
  27  DT  19,0+/5,19+/40,0+/B5*E
  28  LD  (3 P)AUSES TOO SHORT        (3 T)OO LONG      +/B5*E
  29  FN  MV+/C7+/NC+/,19+/*E
  30  FN  MV+/C5+/NC+/,36+/*E
  31  DT  25,0+/2,25+/40,0+/B5*E
  32  DT  29,0+/2,29+/40,0+/    (P)RESS (SPACE BAR )TO GO ON.*E
  33  EPI 30,39+/2,30+/1,37+/+/1+/*E
  34  AA  (8+/)ZZ*E
FIN1*E
SS 1  NC  COMMENT-  WHEN ADDED UNITS ARE USED, THIS WILL GIVE THE STUDENT THE OPTION OF SIGNING OFF OR CONTINUING WITH A
          NOTHER PATIENT.*E
   2  PR  *E
   3  DE  0+/32*E
   4  DT  3,0+/8,3+/40,0+/  (T)HIS COMPLETES THE COURSE.*C*I*I  (I )HOPE THAT YOU ENJOYED IT, THAT YOU*C*ILEARNED SOMETH
          ING FROM IT, AND THAT YOU*E
   5  DT  10,0+/4,10+/40,0+/WILL RETURN SOME TIME.*E
   6  DT  14,0+/4,14+/40,0+/  (I )MOST CERTAINLY ENJOYED INTERACTING*C*IWITH YOU.*E
   7  DT  20,0+/2,20+/40,0+/ (P)LEASE PRESS THE (SPACE BAR )TO SIGN OFF.*E
   8  EP  30,0+/2,30+/1,10+/+/1+/END COURSE*E
   9  AA  (8+/)AA*E
END*E
   1  EN  *E
**END
```

APPENDIX E

Technical Aspects and Problems

APPENDIX E

Technical Aspects and Problems

Computer Facilities

IBM 1500 Instructional System based on an IBM 1130 computer with 32 K (16-bit word) 3.6 microsecond core memory, 5 disk packs providing 2.5 millions words of storage, two 2415 tape drives, 1132 printer, and 1443 card read/punch. During program development the number of terminals was increased from 6 to 15.

Factors Concerning Speed With Which the Display-Screen Hand Could be Raised

a. Requirement for reassembly of course. During on-line course authoring, input instructions are written on the disk in the next available space, either within the course segment being authored or at the end of all course segments. Either way, if a change is made in the interior of a segment, the changes will be placed on the disk some physical distance from the original material. During course execution, the effect of this will be to increase access time to the revised section because of read head search time. Reassembly places all instructions in the proper physical order on the disk, but the process takes some time (about two hours for this program but it is less for shorter course segments).[1] The effect of reassembly was assessed by measuring the time between the start of the tone and the lowering of the hand under reassembled and non-reassembled conditions. The programing involved was, generally, as follows:

1. Display problem
2. Read internal clock (C1)
3. Student presses tone switch
4. Response latency stored (L1)
5. Input setting tested. If correct, RAISE HAND
6. Branch to timing routine
7. Read internal clock (C2)
8. Wait for release of switch
9. Student releases tone switch
10. Store response latency (L2)
11. LOWER HAND

Some additional loading and testing also is done during this sequence, and there are three branches, two of which are done via return registers. The precise coding may be seen in Appendix D.

The duration measured, then, was from step 3 (student presses tone switch) through step 11 (hand lowered). If one instruction in this sequence is changed, this change is physically added to a different part of the disk resulting in increased access time of up to two seconds. This response time increases with a larger number of changes.

---

[1] During the summer of 1969 a new reassembly routine was installed that markedly reduces the time to reassemble course segments that do not contain an excessive number of labels.

Reassembly of a program segment aligns all instructions physically on the disk and, depending upon the number of changes previously made, may markedly reduce program response time.

The implications of the above are the following: 1) reassembly should always be performed prior to running subjects on course material; 2) if timing is an important consideration, course segments should be reassembled after changes prior to author evaluation; and 3) due to the relationship between the length of a course segment and the time needed for its reassembly, course segments should be kept relatively short (less than 160 sectors) if frequent reassemblies are to be performed.

b. Number of instructions required for the display. The importance of the number of instructions (dt's or dti's) was not at first recognized. However, it was found that the processing of display instructions may be relatively slow. The initial instruction sets for manipulating the displayed subject consisted of thirteen instructions to raise the hand and thirteen to lower it. Each set displayed a complete man.

The final instruction sets consisted of five instructions for the image with the hand down and one instruction for the raised hand. The latter modified a portion of the hand down display by replacing the "patient's" lowered right hand with a raised hand. This image was completely replaced by the display with the lowered hand. These displays were necessarily more crude than those with more instructions, but the gain in display time was considered more important than the beauty of the man.

The obtained times for processing and displaying the raised hand were measured by a stopwatch after reassembly of the program. The time was measured from the depression of the tone key to the completion of the hand-up display. More than 20 measurements of each type of display were made. Times for the initial set with 13 display instructions ranged from 2 to 2.5 seconds. For the final set with one display instruction the range was from 1 to 1.5 seconds, a gain of a full second which, for this purpose, was important. This difference may have been due to a variety of factors, including the following:

1. The display with one dti contained fewer characters and lines and could be placed on the video buffer more rapidly.
2. The large number of index and reverse index instructions in the 13 dti display may have excessively degraded processing.

c. Impact of others on the system. The relatively long sequence of instructions given in section "a" above can be used to illustrate some of the difficulties encountered when others use the system at the same time as the AUDIO course. When the student depresses the tone switch, a pulse is transmitted to the computer. It is tested and the hand is raised if appropriate. If, however, someone at another station has the attention of the computer at the time the switch is depressed, processing of the pulse will not take place until processing of the other terminal is finished. This delay may be very brief or it may be in the order of several seconds, depending upon the type of processing being done. If more than one other terminal is in operation, this delay is compounded due to the sequential processing of terminals.

Due to the above process, a delay in the raising of the hand may occur. Meanwhile, the student is counting the time he has depressed the switch and releases it after two to four seconds. If the hand has not been raised yet, the pulse sent by the release of the switch is lost because one pulse from that terminal is already in the queue for processing. This can also happen if the student releases the tone switch too quickly (after a depression of less than one second, for example). For this reason a message telling the student his tone was too short is displayed if the second pulse is not received within six seconds of the first, and the hand is lowered.

Usually, if the other terminals were in student mode, it was found that little interference was experienced because processing takes place very quickly for those students. However, interference can be encountered if the student programs are complex, use a large number of slow functions, or contain many long branches. The major interference is caused by other terminals signed on in author mode. Due to the special instruction set available to authors, more processing time is required by authors than by students. Furthermore, author commands to delete, replace, or move instructions, or call a macro may take one or more seconds to execute, and authors will frequently execute unreassembled course material which may require several seconds.

For these reasons it is best to run students at times no one else was on the system.

d. Effect of processing and types of coding. During the search for maximum efficiency a number of hardware and software factors were considered. Of primary concern was the arm movement required for seeking material on the disk. A capability was added to the 1502 station control which allowed the monitoring of any station by the CRT in the control room. While a student worked through the program, it was possible to watch what occurred on the CRT while listening to the disk arm movements (no one else was signed on). These arm movements are clearly audible and can be associated with specific instructions in the program coding. This method allowed the detection and improvement of some unsuspected sources of inefficiency.

The type of branch used has an impact upon arm seeking. Apparently a branch to a label is the most efficient; the only arm movement is to the label. The address of the label is stored with the branch. A branch to a pr0 is equally efficient because the address of the last pr is stored in core. A branch to prn where n is 1 or more requires a search through all following instructions and is less efficient. A branch to a return register requires reading the return register and then finding and branching to the label found; this is the least efficient and seems to require a good deal of arm movement.

A second consideration was the number of transfers of data to core from the disk for processing. This system transfers 2 sectors at a time, but if all operations could not be completed within this number, or if there are branches to other sectors, a small amount of added time was required to move in the next set of 2 sectors. More important, however, was the ceiling of 100 instructions before rescheduling. If 100 instructions were processed without reaching an ep, processing was rescheduled (temporarily halted and processing of other terminals initiated). Processing was continued after that of the other terminals was completed. For these reasons, economy of coding was a necessity, but at times this proved to be difficult with Coursewriter II due to the requirements of the course.

The processing time for Coursewriter II functions can be a factor in efficiency. During the early stages of program development few functions were available. However, one function, DCOUNT, was used to load the contents of a counter into a buffer for display purposes. It was later found that this function required between one and two seconds to execute! Fortunately, by that time, a more efficient function had been developed which could be substituted. At some time a table of average function execution times under normal system conditions should be compiled. The availability of a function in core is also a factor. If a function is not frequently used, it has to be located and loaded into the function area when it is to be used, which takes some tome.

Some Coursewriter II instructions may have an unexpected impact on other instructions. It was found that the pause (pa) instruction causes rescheduling, but allows successive operations to be completed. For this reason, a function to read the system clock (sf function) executed at the time the pa was encountered, and was not updated after the pause. Thus, the wrong time was stored. This created a great deal of difficulty with the tone timing routine before the trouble was found. For similar reasons, some f instructions also affect the timing and it has recently been found that the dl and pae instructions also do so because they cause rescheduling. It has been suggested by systems staff that these later instructions cause rescheduling due to an error in coding. In the future this condition may be corrected.

e. Alternatives to the "patient." As discussed in the text of this report, it was necessary to provide a rapid "patient" response to the student after he depressed the tone switch. Due to the slow response of the first "patient" and while the second man was being developed, other alternatives were explored. These consisted of lighting the patient signal light (as if the "patient" had pressed a button), using photographs of a "patient" on the image projector, and putting a spot of light on the display screen. All of these could be done with very few instructions but all had disadvantages. The image projector made a characteristic noise when changing images; the student might have been trained to auditory cues. The spot of light is quite remote from normal feedback modes used in normal testing but was evaluated as a last resort. The use of the patient signal light was an acceptable response mode, but was not considered as good as an overt response such as raising a hand. Fortunately, these alternatives were not found to be significantly faster than the new "patient", so they were discarded.

Advantages and Disadvantages of the Image Projector

The image projector provides an excellent capability for random access to a large number of color images which can be used for effective instructional displays, illustrations (types of aircraft, photomicrographs of microbes, or labeled photos of the Audiometer Trainer Unit), or text to be used for answering a series of questions. However, a number of problems were encountered in the production of the image reel used in this course (it should be noted that this was one of the first reels produced for this laboratory).

The images photographed included both still pictures taken on a copying stand and live pictures taken in a studio. Exposures for the Kodachrome II film were determined by technical personnel at the University photographic service. An Arriflex camera modified to take single exposures was used. Because of a tendency for light leaks to occur if a single frame was in position for more than a minute, three frames were exposed for each image. This precaution proved valuable because light leaks were found on the finished reel as well as some unexplained blank frames.

The original film was somewhat underexposed and of fairly high contrast. It was felt that by overexposing the internegative slightly the exposure would be corrected. Three generations of release prints were made because the first proved to be too dark and the second, although lighter than the first, was still too dark to be acceptable. The third was as light as could be made and was marginally acceptable; the text, audiogram, and ATU images were good but the studio photographs of a subject wearing earphones were still slightly too dark. However, time did not allow the rephotographing of all images, which would have been required, and it was decided that the third release print was of good enough quality for subject trials.

With use, it was found that the address track of the release prints was slightly out of alignment which occasionally caused image projector errors until this condition was discovered. The problem was temporarily solved by re-adjusting the image projector to the alignment of the film, a process that was simplified by the fact that only one image projector was used for all program tests. However, the re-adjustment made the terminal less useful for other courses that used image reels with correct address tracks.

It was decided that the misalignment of the address track might have been due to two possible reasons; torn sprocket holes on the address master or slippage of the printing address master at the sound head of the printer. A final determination of cause could not be made.

A problem that was initially encountered was the breaking of film in the image projector, sometimes within the first five uses. This may have been due to a defective sprocket in the film transport or to the rapid drying of the film caused by hot air being blown over it. It was found that coating new film with a silicon preparation increased the resistance of the film to breakage, but the cause of the problem was referred to the San Jose office of IBM.

Evaluation of Coursewriter II

Coursewriter II proved to be a reasonably effective langauge for writing instructional materials. Its power is continually being enhanced by the addition of new functions and improvement of old functions. For normal instructional sequences it seems to be quite adequate, although the number of switches, counters, and buffers is, at times, very limiting. With the introduction of functions that use four buffers for processing, a total of five buffers is not adequate. However, it is the functions that provide the greatest flexibility in using the language; with sufficient ingenious coding and the use of functions almost anything can be done.

The major weakness of Coursewriter II, from the standpoint of the audiometry course, is the limited branching capability that requires that only one test be made at a time, a simple logical IF. This is sufficient for many routine uses, but for complex branching decisions a long string of logical IF's may be required. More powerful operations such as those found in FORTRAN (the arithmetic IF, the computed GO TO, or a complete logical IF that permits an operation other than branching if the IF is true or which permits more than one logical statement in the logical expression) could replace these strings.

These, combined with a capability to branch to a sequence number within a label (perhaps specified in a counter or a branch statement) would greatly simplify complex branching decisions and could allow for a more flexible course of instruction. Such capabilities would be especially useful for decisions that are based on the values of more than one counter (e.g., branch to review if counter 5 is greater than 3 and counter 6 is greater than 2, or if counter 7 is greater than 4) or if a variety of branches are possible from one counter (e.g., branch to brief review if counter 5 is 2, long review of counter 5 is 4, or to the beginning if counter 5 is 6).

Improvements in the MACRO capability would simplify operations such as were encountered in producing different audiograms. For this it was necessary to use specific labels, and it was possible to use different segments for each iteration. At present, it is necessary to use punched cards, with changes made by inserting new cards at specific places in the deck for each new segment. A MACRO process that accepts given labels would greatly simplify this repetitious process.

During the coding of the audiometry course it was found that the same sequences of instructions were used at different places. This necessitated the repeated entry of these sequences. A command to copy a specific series of instructions would greatly simplify this task in cases where there is not sufficient repetition to warrant a MACRO or where sequences are being tried out prior to complete implementation. Such a capability could be developed to be analogous to the MOVE command.

Problems With the ATU and Their Solution

For a first-generation device of its complexity, the Audiometer Trainer Unit worked very well. However, as a result of experience gained from writing the course, it was found that two modifications of the ATU were needed after delivery. A signal upon release of the tone switch and program control of the patient signal light were added. The latter caused some difficulty because of the need for sending a signal to the light. This signal had to be added to other system signals to the ATU that were appropriate feedback to a typewriter terminal.

One hardware error, which resulted in erroneous position codes being transmitted to the computer, proved to be extremely difficult to correct. It was traced to the switch used for giving tones, a one-pole, two-position slide-type switch designed for silent operation. Occasionally during depression the switch blade vibrated against the contacts and caused more than one signal to be placed on the ring counter. This usually ANDed the binary codes and produced a characteristic error. The problem was solved by reducing the acceptance interval for the scan cycle so that vibrations would be excluded.

The tone switch was also the source of an added difficulty; the reset spring broke twice during the project. The second break occurred just before the last two students but it was impossible to have it repaired immediately. Consequently, the last two subjects operated the panel by manually pressing and lifting up the tone switch. Although this caused some system errors, the students were able to complete the course successfully. It has not been possible to determine precisely why the springs broke, but a bent metal stop, which limits downward movement of the switch, indicates that someone may have pushed down too hard, probably someone who was not taking the course and was just playing with the ATU. One solution to the problem of people fiddling with the panel would be to fit it with a cover.

Use of the ATU With a 1050 System

The Audiometer Trainer Unit is designed to operate with a 1050 Data Communication System (see Appendix A) but programing was not done for that system. The Coursewriter II programing designed for the 1500 system would require extensive rewriting and translation into Coursewriter I to adapt it for the 1050 system. Instruction in audiometry with the ATU is feasible with this latter system but would lose some of the advantages of the 1500 system due to the composition of the 1050 terminal (slide projector, typewriter, and audio unit). The "patient" would have to be placed on slides or the patient signal displayed by the patient signal light, both of which are considered less effective than the "patient" on the display screen (see Appendix E, 2e for a further discussion). Most text would have to be displayed by the slow typewriter or by slides, which would require more than one slide tray (each tray contains 80 slides). The review sections would have to be modified to use a question format, considered less effective than the programed format used in the present text. The display of tone durations would be less effective if they had to be typed and the student had to look over at a typewriter. The running tally of responses would be difficult to maintain if it could be interrupted by error messages.

However, the 1050 system has the advantage of being able to be used anywhere; the terminal is connected to the computer by voice grade telephone lines. Consequently the advantage of portability might outweigh the disadvantages of the terminal, and the loss of effectiveness might be minimized by a complete revision to use audio messages extensively. Such a revision would probably require a year to complete if done by a very small staff. However, a large staff working on several sections at once could probably complete the revisions in only a few months.

APPENDIX F

Detailed Course Outline

APPENDIX F

Detailed Course Outline

Unit 1

A. Introduction to use of computer terminal

B. Introduction to course

C. Optional gating test of ability to set panel and give tone; continuation options contingent upon performance; permits student to skip Unit 1

D. Turning on audiometer

E. Use of tone switch

  1. Optional practice in giving tones of specified length

F. Use and manipulation of Channel 1 Output

G. Use and manipulation of Channel 1 Hearing Level; practice with both

H. Use and manipulation of Frequency; practice with all

I. Use of Tone Norm

J. Use of SISI

K. Use of Channel 2; practice setting of Channel 2 components with Channel 1 components; self-practice with a Beltone 10-D portable audiometer

L. Practice setting panel

M. Feedback on tone deviation performance; practice in giving tones provided if less than 80% correct

N. Feedback on panel setting performance-options for continuing with further practice, review of selected topics, or going to next unit

O. Practice with settings, with final summary feedback

P. Index for selecting topics for review

Q. Review items; paragraphs reiterating all topics presented

Unit II

A. Series of images with right and wrong placement of earphones; subject determines if correct; choice followed by descriptive feedback

B. Preparing the subject for testing

C. Option of vocabulary review

D. Directed step-by-step practice in giving hearing tests. All frequencies right ear. During each frequency, S predicts whether another pass is needed and determines the final threshold. He then plots (with light pen) the point on an audiogram projected on the display screen.

E. For the last three frequencies, students are initially asked to observe carefully the sequence of intensity levels, then to guess the next one, and finally to type in their predictions.

F. Feedback over this unit is provided concerning panel setting errors and tone durations. Practice in tone duration is given if performance was less than 80%, and review of topics is made available if desired.

G. Review of the first descending pass procedure using constructed responses

H. Same type of review with ascending pass

I. Same with last descending pass

J. Same with frequency series

NOTE: At the end of H, I, and J the subject is given the opportunity to repeat any of these review sections.

Unit III

A. Introduction to acceptable pause interval

B. Test of left ear with no guidance; corrective feedback provided in the event of following errors:

1. S descends after 2 No responses
2. S ascends after 2 Yes responses
3. S repeats same level
4. S descends after starting below threshold
5. S attempts to use more than 3 passes

C. Feedback concerning correctness of procedure and duration of tones and pauses

D. Entry of obtained thresholds and feedback.

Unit IV

Various audiograms for practice. A brief description of patient history and patient characteristics is given, then student tests with no guidance. However, errors are counted.

APPENDIX G

Oral Postprogram Questionnaire

APPENDIX G

Oral Postprogram Questionnaire

APPENDIX G

Oral Postprogram Questionnaire

1. Do you like this method of learning?
2. Was the speed of the program too fast, too slow, or about right?
3. Was the speed of the testing procedure and the patient response too fast, too slow, or about right?
4. Was the program too difficult or easy or about right? How about the vocabulary?
5. Compare this method with the course work and practice you have had in audiometry - is it good, better, or worse? Was the patient response about the same as you have experienced?
6. Would you recommend this as practice rather than humans, before testing humans, or after testing people?
7. Was there enough variety in the thresholds and procedures?
8. Does the program teach anything wrong?
9. Did you like (or would you like) the pause duration and the tone duration in the last part?
10. How do you like the audiometer panel?
11. Do you have any added comments on the program or on CAI?

APPENDIX H

Samples of Complete Unit 3 Audiograms

APPENDIX H

Samples of Complete Unit 3 Audiograms

Following are complete records of the performance of seven students on the threshold finding task in Unit 3. These were selected as being representative of the records obtained. The intensities are sequenced under the frequencies tested, and the frequencies are sequenced in the order tested. Descending and ascending passes are indicated by arrows (↓ indicating descending, ↑ is ascending). The lowest intensity for each pass at which a "patient" response was obtained is underlined (on some passes no level is underlined because a response was not obtained). The final threshold determined by the student for each frequency is given just to the right of the frequency. Basic data for each student is included on each record.

To allow comparison, a correct procedure for testing all frequencies is given first. This procedure exactly represents the principles taught in the course. The lowest "patient" responses for each pass that were built in to the program are indicated on this record, as are the correct thresholds.

A recommended correct procedure for obtaining the audiogram for Unit 3 would be as follows:

1000 Hz: 5 db

↓		↓
40		40
30		30
20		20
15	15	15
10	10	10
5	$\overline{5}$	5
$\overline{0}$	0	0
-5	↑	$\overline{-5}$
		-10

2000 Hz: 20 db

↓		↓
35	25	50
25	20	40
15	$\overline{15}$	30
$\overline{10}$	10	25
5	↑	20
		$\overline{15}$
		10

4000 Hz: 40 db

↓		↓
50		70
40	40	60
$\overline{35}$	$\underline{35}$	50
30	↑	45
		40
		$\overline{35}$
		30

8000 Hz: 75 db

	↓	
80	100	
$\overline{70}$	90	
↑	80	80
	75	75
	$\overline{70}$	$\overline{70}$
	65	↑

500 Hz: -5 db

↓		↓
40		35
30		25
20		15
15		10
10	10	5
5	5	0
0	$\overline{0}$	-5
-5	-5	$\underline{-10}$
$\overline{-10}$	↑	

250 Hz: -10 db

↓		↓
25		25
15		15
5		5
0	0	0
-5	$\underline{-5}$	-5
$\underline{-10}$	↑	$\underline{-10}$

125 Hz: -5 db

↓		↓
20		25
10		15
0	0	5
$\overline{-5}$	$\underline{-5}$	0
-10	↑	-5
		$\overline{-10}$

Student: X3

Background: Student in Audiology Course AR Rank: 19$\frac{1}{2}$ Performance Rank: 23

1000 Hz: 0 db

↓		↓
40		
30		25
20		20
15	15	10
10	10	5
5	5	0
0	0	0
-5	↑	-10

2000 Hz: 15 db

↓		↓
40		
30		35
30	35	25
20	30	20
10	15	15
5	10	5
	↑	

4000 Hz: 5 db

↓	↓	
40	50	
30	40	30
30	30	↑
20	25	

8000 Hz: 75 db

	↓	
	100	
110	100	
100	90	85
100	80	75
60	70	70
40	65	↑
40		
↑		

500 Hz: 5 db

↓		↓
30		25
20		20
15	15	15
10	10	10
0	5	5
-5	0	0
-10	-5	-5
	↑	-10

250 Hz: -10 db

↓		↓
40		
30		
20		
15		
10		
5		
0	0	
-5	-5	-5
-10	↑	

125 Hz: -5 db

↓		↓
40		
30		
20		25
15		15
10		5
5	5	0
0	0	-5
-5	-5	
	↑	

Student: X8

Background: Teacher AR Rank: 16 Performance Rank: 21

1000 Hz

↓	↓
40	40
30	30
20	20
15	15
10	10
5	5
0	0
-5	-5

2000 Hz

40
30
20
10
10
5
0
↑

1000 Hz: 0 db
(repeated)

↓		↓
40		
30	40	30
20	30	20
10	20	15
5	10	10
0	5	5
-5	0	0
	↑	

2000 Hz: 15 db
(repeated)

↓	50	↓
40	40	40
30	30	30
20	25	25
15	20	20
10	15	15
5	10	
	↑	

4000 Hz: 20 db

↓		↓	
40			
30	50		35
30	45	40	35
20	40	30	↑
	35		
	30		
	25		
	25		
	↑		

8000 Hz: 70 db

↓	80		↓
40	70		90
30	60		80
20	60		70
	60		60
	50		
	45		
	40	100	
	30	90	
	↑	70	
		↑	

500 Hz: -5 db

↓		↓
40		
30		
20		
15		
10		0
5		0
0	5	-5
-5	0	
-10	-5	
	↑	

250 Hz: -5 db

↓
40
30
20
15
10

125 Hz: (-5 db)

Omitted

Student: X9

Background: Nurse AR Rank: 13 Performance Rank: 13

1000 Hz: 0 db

↓		↓	
40		30	
30		20	
20	15	10	
10	10	5	
5	5	0	0
0	0	-5	-5
-5	↑		↑

2000 Hz: 20 db

↓		↓	↓
40		40	
30		30	
20	25	25	
15	15	20	20
10	10	15	15
5	5		
0	↑		

4000 Hz: 30 db

↓		↓	
40	40		
30	35	35	
25	30	30	30
20	25	25	
	↑		↑

8000 Hz: 75 db

↓	85	↓	
40	80	80	
35	75	75	75
	75	70	70
	70		↑
	65		
	60		
	55		
	50		
	45		
	40		
	↑		

500 Hz: -10 db

↓		↓	
40			
30			
20			
15			
10	10		
5	5	5	5
0	0	0	0
-5	-5	-5	-5
-10		-10	-10
	↑		↑

250 Hz: -10 db

↓		↓
40		
30		
20		
15		
10		
5		
0	0	-5
-5	-5	-10
-10		
	↑	

125 Hz: - 5 db

↓		↓	
40			
30			
20			
15			
10			
5	5		
0	0	0	0
-5	-5	-5	-5
-10		-10	
	↑		↑

Student: X14

Background: Grad Student, Speech and Hearing AR Rank: 18 Performance Rank: 3

1000 Hz: 10 db

↓		↓
40		40
30		30
20		20
15	15	15
10	10	10
5	5	5
0	0	0
-5	↑	-5

2000 Hz: 20 db

↓	
40	
30	
20	20
15	15
10	↑

4000 Hz: 40 db

		↓	
↓		65	
40		55	
30	35	45	
25	30	40	40
		35	35
	↑	30	↑

8000 Hz: 75 db

80	↓	
70	75	75
40	65	70
↑		↑

500 Hz: 5 db

↓		↓
40		35
30		25
20		15
15		10
10	10	5
5	5	0
0	0	-5
-5	-5	-10
-10	↑	

250 Hz: -10 db

↓
40
30
20
15
10
5
0
-5
-10
-10

125 Hz: -5 db

↓		↓
40		30
30		20
20		15
15		10
10		5
5		5
0	0	5
-5	-5	0
-10	↑	-5
		-10

Student: X15

Background: Completed Audiology Course AR Rank: 12 Performance Rank: 7$\frac{1}{2}$

1000 Hz: 5 db

↓		↓		
40		40		
40		30		
30		20		
20		15		↓
15		10		10
10		5	0	0
5		0	-5	0
5		-5	-5	-5
5	10	-10	-5	-10
0	5		↑	
0	5			
	↑			

2000 Hz: 20 db

↓	↓	
35	40	
25	30	
	30	
	20	20
	15	20
	10	15
		↑

4000 Hz: 35 db

↓		
40	35	35
30	30	30
20	25	
	↑	↑

8000 Hz: 75 db

	↓	
80	75	80
70	70	75
60		↑
50		
40		
↑		

500 Hz: -10 db

↓			
40			
30			
20			
15			
10		↓	
5	5		
0	0	0	
-5	-5	-5	-5
-10	↑	-10	↑

250 Hz: -10 db

↓	
40	
30	
20	
15	
10	
5	
0	0
-5	-5
-10	↑

125 Hz: -5 db

↓	↓	
40		
30		
20		
15	0	
10	0	↓
5	-5	
0	-5	-5
-5	-5	-10
-10	-10	
-10		

Student: X18

Background: Nurse AR Rank: 6.5 Performance Rank: 1

1000 Hz: 5 db

↓	
	30
30	20
20	15
10	10
5	5
0	0
-5	↑

2000 Hz: 20 db

↓	
30	
20	20
10	15
5	10
0	5
	↑

4000 Hz: 40 db

↓		↓	
30		60	
20		50	
10		40	
5	25	35	
	15	30	40
	↑		35
			↑

8000 Hz: 75 db

↓		↓
40	75	
35	70	70
	65	
	60	
	55	
	50	
	45	
	40	
	↑	

500 Hz: -5 db

↓			
40			
30			
25			
20			
15		↓	
10	10		
5	5	5	
0	0	0	
-5	-5	-5	-5
-10		-10	
	↑		↑

250 Hz: -10 db

↓	
30	
20	
10	
5	10
0	0
-5	-5
-10	↑

125 Hz: -5 db

↓		
30		
20		
15		↓
10		10
5		5
0	0	0
-5	-5	5
-10	↑	-5

Student: X25

Background: Speech and Hearing Supervisor AR Rank: 1 Performance Rank: 22*

1000 Hz: 5 db

↓		↓	
30			
20		5	15
10	10		10
5	5		5
0	0		
-5	↑		↑

2000 Hz: 20 db

↓	
35	
25	25
15	20
10	15
	↑

4000 Hz: 75 db

Omitted

8000 Hz: 75 db

↓		↓		↓	
		100		100	
50		90		90	
50		80		80	
50		80		75	75
40	60	75	80	70	70
	↑	70	75	65	↑
		65	70		
			↑		

500 Hz: -5 db

↓		
100		
90		
80		
75		
70		
65		
60		
55		
50		↓
45		
40		
35		35
30		25
25		15
20		10
15		5
10	10	0
5	5	-5
5	0	-10
-5	-5	
-10	↑	

250 Hz: -5 db

↓	
25	
15	
5	
0	
-5	0
-10	-5
	↑

125 Hz: 0 db

↓	
25	
25	
15	
5	
0	0
-5	-5
-10	↑

---

*Low rank a result of omitting 4000 Hz.